remote sensing

Supplementary Materials

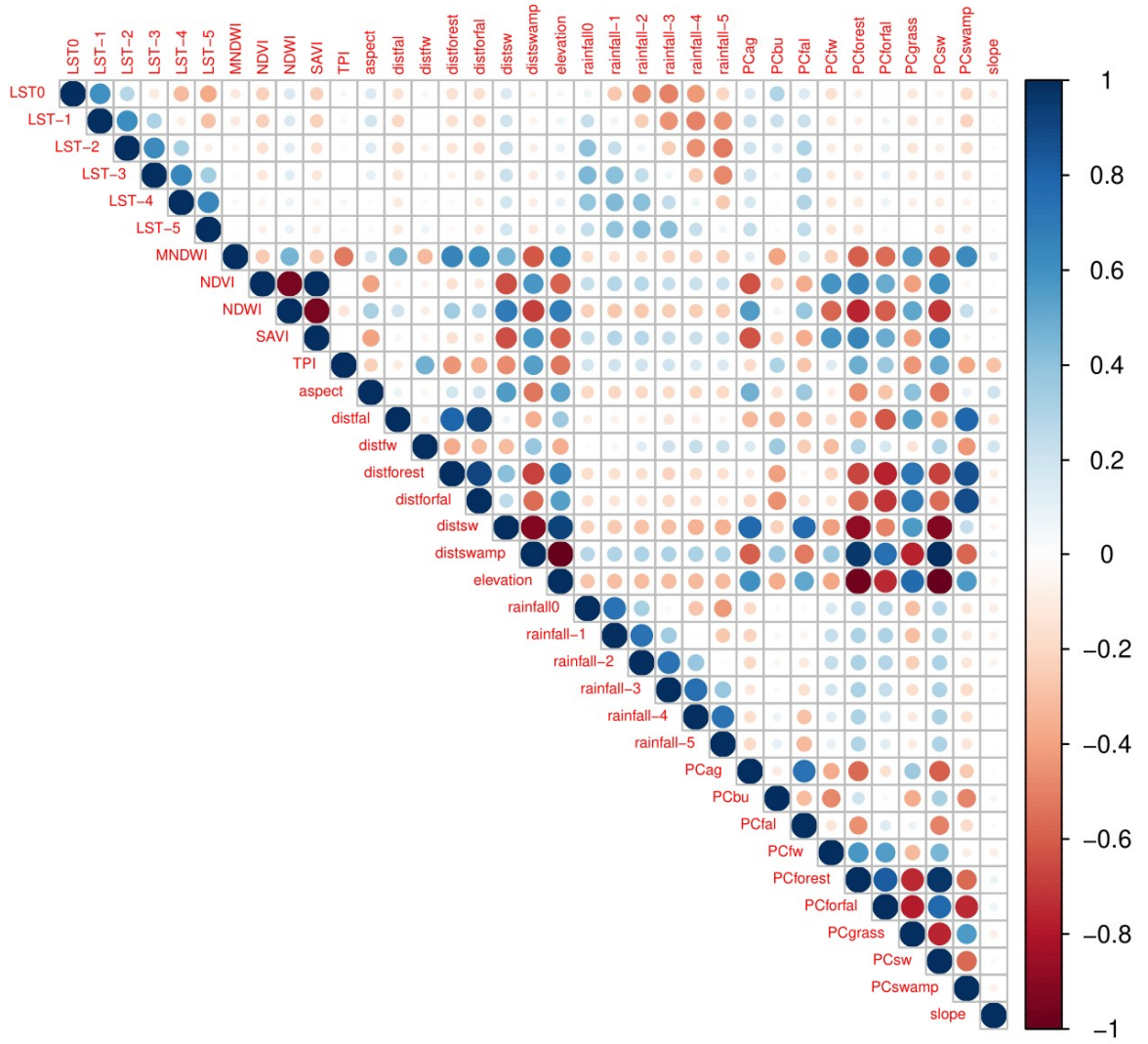

Figure S1. Variable correlation plot for *An. gambiae* and *An. paludis*.

Rainfall^{-x} where −x is the number of months prior (Rainfall^{0} = current month, Rainfall^{-1} = one month prior etc.), LST = land surface temperature, PC = proportional coverage of, dist = distance to, bu = built-up, fal = fallow, forest = forest, forfal = forest and fallow combined, grass = grassland, ag = agriculture; fw = flowing water, sw = static water, clear = clearing, MNDWI = Modified Normalised Difference Water Index, NDVI = Normalised Difference Vegetation Index, NDWI = Normalised Difference Water Index, SAVI = Soil Adjusted Vegetation Index, TPI = Topographical Position Index.

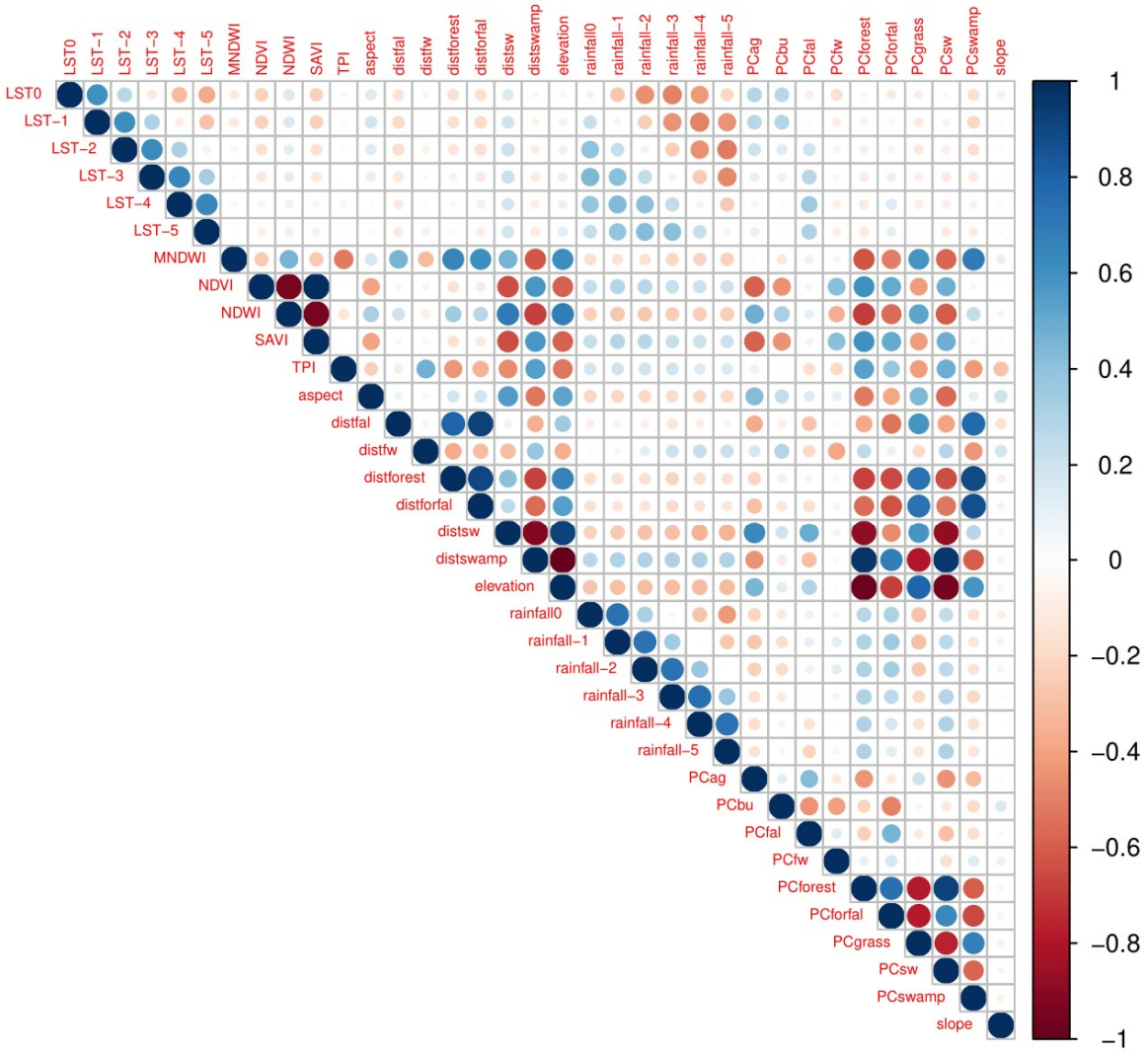

Figure S2. Variable correlation plot for *An. funestus*.

Rainfall^{-x} where −x is the number of months prior (Rainfall^{0} = current month, Rainfall^{-1} = one month prior etc.), LST = land surface temperature, PC = proportional coverage of, dist = distance to, bu = built-up, fal = fallow, forest = forest, forfal = forest and fallow combined, grass = grassland, ag = agriculture; fw = flowing water, sw = static water, clear = clearing, MNDWI = Modified Normalised Difference Water Index, NDVI = Normalised Difference Vegetation Index, NDWI = Normalised Difference Water Index, SAVI = Soil Adjusted Vegetation Index, TPI = Topographical Position Index.

Table S1. Confusion matrix for the Lodja land cover classification.

Classified	Reference								
	F	**G**	**AG**	**FA**	**BU**	**WF**	**WS**	**Total**	**UA (%)**
F	353		5	20			1	379	93.14
G	2	70	3		3			78	89.74
AG	3		18	3				24	75.00
FA	18		2	86				106	81.13
BU	2				30			32	93.75
WF						30	2	32	93.75
WS							30	30	100.00
Total	378	70	28	109	33	30	33	681	
PA (%)	93.39	100.00	64.29	78.90	90.91	100.00	90.91		OA (%) = 90.60

F = forest, G = grassland, AG = agriculture, FA = fallow, BU = built-up, WF = water flowing, WS = water static, UA = User's accuracy, PA = Producer's accuracy, OA = Overall accuracy.

Table S2. Confusion matrix for the Kapolowe land cover classification.

	Reference									
Classified	**F**	**G**	**AG**	**FA**	**BU**	**WF**	**WS**	**SW**	**Total**	**UA (%)**
F	89		5	1				2	97	91.75
G	1	75	11	5					92	81.52
AG		3	206	10	3				222	92.79
FA		1	17	70				1	89	78.65
BU			1		33				34	97.06
WF		1	1			28	1		31	90.32
WS							33	2	35	94.29
SW		2				1		90	93	96.77
Total	90	82	241	86	36	29	34	95	693	
PA (%)	98.89	91.46	85.48	81.40	91.67	96.55	97.06	94.74		OA (%) = 90.04

F = forest, G = grassland, AG = agriculture, FA = fallow, BU = built-up, WF = water flowing, WS = water static, SW = swamp, UA = User's accuracy, PA = Producer's accuracy, OA = Overall accuracy.

Table S3. Random forest parameter tuning for *An. gambiae s. l.*

Trees	Minimum Leaf Population	Maximum Nodes	Variables per Split	Bag Fraction	R^2
200	1	unlimited	√ variables	0.5	0.703
200	2	unlimited	√ variables	0.5	0.691
200	3	unlimited	√ variables	0.5	0.689
200	4	unlimited	√ variables	0.5	0.681
200	5	unlimited	√ variables	0.5	0.664
200	6	unlimited	√ variables	0.5	0.660
200	7	unlimited	√ variables	0.5	0.657
200	8	unlimited	√ variables	0.5	0.653

200	9	unlimited	√ variables	0.5	0.645
200	10	unlimited	√ variables	0.5	0.226
1	1	unlimited	√ variables	0.5	0.272
2	1	unlimited	√ variables	0.5	0.364
3	1	unlimited	√ variables	0.5	0.503
4	1	unlimited	√ variables	0.5	0.525
5	1	unlimited	√ variables	0.5	0.531
6	1	unlimited	√ variables	0.5	0.568
7	1	unlimited	√ variables	0.5	0.596
8	1	unlimited	√ variables	0.5	0.576
9	1	unlimited	√ variables	0.5	0.607
10	1	unlimited	√ variables	0.5	0.693
50	1	unlimited	√ variables	0.5	0.682
100	1	unlimited	√ variables	0.5	0.703
300	1	unlimited	√ variables	0.5	0.703
500	1	unlimited	√ variables	0.5	0.693
200	1	2	√ variables	0.5	0.400
200	1	5	√ variables	0.5	0.590
200	1	10	√ variables	0.5	0.621
200	1	20	√ variables	0.5	0.638
200	1	30	√ variables	0.5	0.661
200	1	40	√ variables	0.5	0.678
200	1	50	√ variables	0.5	0.690
200	1	unlimited	2	0.5	0.675
200	1	unlimited	3	0.5	0.679
200	1	unlimited	4	0.5	0.701
200	1	unlimited	5	0.5	0.703
200	1	unlimited	6	0.5	0.701

200	1	unlimited	7	0.5	0.697
200	1	unlimited	8	0.5	0.687
200	1	unlimited	9	0.5	0.685
200	1	unlimited	10	0.5	0.679
200	1	unlimited	11	0.5	0.693
200	1	unlimited	12	0.5	0.679
200	1	unlimited	13	0.5	0.681
200	1	unlimited	14	0.5	0.687
200	1	unlimited	15	0.5	0.683
200	1	unlimited	16	0.5	0.690
200	1	unlimited	17	0.5	0.686
200	1	unlimited	18	0.5	0.687
200	1	unlimited	19	0.5	0.689
200	1	unlimited	20	0.5	0.683
200	1	unlimited	21	0.5	0.693
200	1	unlimited	22	0.5	0.693
200	1	unlimited	23	0.5	0.686
200	1	unlimited	24	0.5	0.677
200	1	unlimited	25	0.5	0.679
200	1	unlimited	26	0.5	0.669
200	1	unlimited	27	0.5	0.669
200	1	unlimited	28	0.5	0.676
200	1	unlimited	29	0.5	0.677
200	1	unlimited	30	0.5	0.687
200	1	unlimited	√ variables	0.1	0.627
200	1	unlimited	√ variables	0.2	0.671
200	1	unlimited	√ variables	0.3	0.674
200	1	unlimited	√ variables	0.4	0.671

200	1	unlimited	√ variables	0.5	0.703
200	1	unlimited	√ variables	0.6	0.687
200	1	unlimited	√ variables	0.7	0.707 *
200	1	unlimited	√ variables	0.8	0.688
200	1	unlimited	√ variables	0.85	0.688
200	1	unlimited	√ variables	0.9	0.655
200	1	unlimited	√ variables	0.91	0.671
200	1	unlimited	√ variables	0.92	0.669
200	1	unlimited	√ variables	0.93	0.679
200	1	unlimited	√ variables	0.94	0.661
200	1	unlimited	√ variables	0.95	0.669
200	1	unlimited	√ variables	0.96	0.668
200	1	unlimited	√ variables	0.97	0.663
200	1	unlimited	√ variables	0.98	0.664
200	1	unlimited	√ variables	0.99	0.672
200	1	unlimited	√ variables	1	0.692

R^2 corresponds to observed mosquito abundance values (from field survey) versus mean predicted abundance values for the validation data set. Default values for variables per split is the square root of the number of variables. * denotes the final parameters used for the predictive random forest modelling.

Table S4. Random forest parameter tuning for *An. funestus*.

Trees	**Minimum Leaf Population**	**Maximum nodes**	**Variables per Split**	**Bag Fraction**	**R^2**
200	1	unlimited	√ variables	0.5	0.837
200	2	unlimited	√ variables	0.5	0.832
200	3	unlimited	√ variables	0.5	0.822
200	4	unlimited	√ variables	0.5	0.793
200	5	unlimited	√ variables	0.5	0.765
200	6	unlimited	√ variables	0.5	0.735
200	7	unlimited	√ variables	0.5	0.722

200	8	unlimited	√ variables	0.5	0.707
200	9	unlimited	√ variables	0.5	0.697
200	10	unlimited	√ variables	0.5	0.837
1	1	unlimited	√ variables	0.5	0.788
2	1	unlimited	√ variables	0.5	0.803
3	1	unlimited	√ variables	0.5	0.796
4	1	unlimited	√ variables	0.5	0.815
5	1	unlimited	√ variables	0.5	0.850
6	1	unlimited	√ variables	0.5	0.859
7	1	unlimited	√ variables	0.5	0.860
8	1	unlimited	√ variables	0.5	0.858
9	1	unlimited	√ variables	0.5	0.859
10	1	unlimited	√ variables	0.5	0.860
50	1	unlimited	√ variables	0.5	0.859
100	1	unlimited	√ variables	0.5	0.850
300	1	unlimited	√ variables	0.5	0.841
500	1	unlimited	√ variables	0.5	0.843
200	1	2	√ variables	0.5	0.724
200	1	5	√ variables	0.5	0.811
200	1	10	√ variables	0.5	0.828
200	1	20	√ variables	0.5	0.833
200	1	30	√ variables	0.5	0.832
200	1	40	√ variables	0.5	0.835
200	1	50	√ variables	0.5	0.836
200	1	unlimited	2	0.5	0.814
200	1	unlimited	3	0.5	0.823
200	1	unlimited	4	0.5	0.841
200	1	unlimited	5	0.5	0.837

200	1	unlimited	6	0.5	0.844
200	1	unlimited	7	0.5	0.844
200	1	unlimited	8	0.5	0.849
200	1	unlimited	9	0.5	0.849
200	1	unlimited	10	0.5	0.843
200	1	unlimited	11	0.5	0.847
200	1	unlimited	12	0.5	0.854
200	1	unlimited	13	0.5	0.852
200	1	unlimited	14	0.5	0.848
200	1	unlimited	15	0.5	0.849
200	1	unlimited	16	0.5	0.845
200	1	unlimited	17	0.5	0.851
200	1	unlimited	18	0.5	0.847
200	1	unlimited	19	0.5	0.847
200	1	unlimited	20	0.5	0.846
200	1	unlimited	21	0.5	0.848
200	1	unlimited	22	0.5	0.844
200	1	unlimited	23	0.5	0.847
200	1	unlimited	24	0.5	0.849
200	1	unlimited	25	0.5	0.847
200	1	unlimited	26	0.5	0.846
200	1	unlimited	27	0.5	0.845
200	1	unlimited	28	0.5	0.846
200	1	unlimited	29	0.5	0.846
200	1	unlimited	30	0.5	0.842
200	1	unlimited	√ variables	0.1	0.630
200	1	unlimited	√ variables	0.2	0.739
200	1	unlimited	√ variables	0.3	0.806

200	1	unlimited	√ variables	0.4	0.830
200	1	unlimited	√ variables	0.5	0.837
200	1	unlimited	√ variables	0.6	0.848
200	1	unlimited	√ variables	0.7	0.855
200	1	unlimited	√ variables	0.8	0.854
200	1	unlimited	√ variables	0.85	0.847
200	1	unlimited	√ variables	0.9	0.859
200	1	unlimited	√ variables	0.91	0.861 *
200	1	unlimited	√ variables	0.92	0.858
200	1	unlimited	√ variables	0.93	0.857
200	1	unlimited	√ variables	0.94	0.858
200	1	unlimited	√ variables	0.95	0.860
200	1	unlimited	√ variables	0.96	0.860
200	1	unlimited	√ variables	0.97	0.857
200	1	unlimited	√ variables	0.98	0.855
200	1	unlimited	√ variables	0.99	0.855
200	1	unlimited	√ variables	1	0.845

R^2 corresponds to observed mosquito abundance values (from field survey) versus mean predicted abundance values for the validation data set. Default values for variables per split is the square root of the number of variables. * denotes the final parameters used for the predictive random forest modelling.

Table S5. Random forest parameter tuning for *An. paludis*.

Trees	Minimum Leaf Population	Maximum Nodes	Variables per Split	Bag Fraction	R^2
200	1	unlimited	√ variables	0.5	0.426
200	2	unlimited	√ variables	0.5	0.422
200	3	unlimited	√ variables	0.5	0.420
200	4	unlimited	√ variables	0.5	0.419
200	5	unlimited	√ variables	0.5	0.409
200	6	unlimited	√ variables	0.5	0.400

200	7	unlimited	√ variables	0.5	0.391
200	8	unlimited	√ variables	0.5	0.393
200	9	unlimited	√ variables	0.5	0.390
200	10	unlimited	√ variables	0.5	0.426
1	1	unlimited	√ variables	0.5	0.199
2	1	unlimited	√ variables	0.5	0.327
3	1	unlimited	√ variables	0.5	0.383
4	1	unlimited	√ variables	0.5	0.404
5	1	unlimited	√ variables	0.5	0.395
6	1	unlimited	√ variables	0.5	0.392
7	1	unlimited	√ variables	0.5	0.425
8	1	unlimited	√ variables	0.5	0.445
9	1	unlimited	√ variables	0.5	0.443
10	1	unlimited	√ variables	0.5	0.423
50	1	unlimited	√ variables	0.5	0.431
100	1	unlimited	√ variables	0.5	0.433
300	1	unlimited	√ variables	0.5	0.432
500	1	unlimited	√ variables	0.5	0.440
200	1	2	√ variables	0.5	0.251
200	1	5	√ variables	0.5	0.329
200	1	10	√ variables	0.5	0.345
200	1	20	√ variables	0.5	0.383
200	1	30	√ variables	0.5	0.406
200	1	40	√ variables	0.5	0.414
200	1	50	√ variables	0.5	0.419
200	1	unlimited	2	0.5	0.411
200	1	unlimited	3	0.5	0.411
200	1	unlimited	4	0.5	0.417

200	1	unlimited	5	0.5	0.426
200	1	unlimited	6	0.5	0.433
200	1	unlimited	7	0.5	0.432
200	1	unlimited	8	0.5	0.443
200	1	unlimited	9	0.5	0.425
200	1	unlimited	10	0.5	0.430
200	1	unlimited	11	0.5	0.439
200	1	unlimited	12	0.5	0.441
200	1	unlimited	13	0.5	0.438
200	1	unlimited	14	0.5	0.439
200	1	unlimited	15	0.5	0.437
200	1	unlimited	16	0.5	0.435
200	1	unlimited	17	0.5	0.437
200	1	unlimited	18	0.5	0.431
200	1	unlimited	19	0.5	0.435
200	1	unlimited	20	0.5	0.436
200	1	unlimited	21	0.5	0.428
200	1	unlimited	22	0.5	0.429
200	1	unlimited	23	0.5	0.434
200	1	unlimited	24	0.5	0.440
200	1	unlimited	25	0.5	0.447
200	1	unlimited	26	0.5	0.447
200	1	unlimited	√ variables	0.1	0.359
200	1	unlimited	√ variables	0.2	0.377
200	1	unlimited	√ variables	0.3	0.399
200	1	unlimited	√ variables	0.4	0.414
200	1	unlimited	√ variables	0.5	0.426
200	1	unlimited	√ variables	0.6	0.448 *

200	1	unlimited	√ variables	0.7	0.440
200	1	unlimited	√ variables	0.8	0.442
200	1	unlimited	√ variables	0.85	0.434
200	1	unlimited	√ variables	0.9	0.426
200	1	unlimited	√ variables	0.91	0.430
200	1	unlimited	√ variables	0.92	0.432
200	1	unlimited	√ variables	0.93	0.430
200	1	unlimited	√ variables	0.94	0.435
200	1	unlimited	√ variables	0.95	0.437
200	1	unlimited	√ variables	0.96	0.439
200	1	unlimited	√ variables	0.97	0.424
200	1	unlimited	√ variables	0.98	0.431
200	1	unlimited	√ variables	0.99	0.422
200	1	unlimited	√ variables	1	0.442

R^2 corresponds to observed mosquito abundance values (from field survey) versus mean predicted abundance values for the validation data set. Default values for variables per split is the square root of the number of variables. * denotes the final parameters used for the predictive random forest modelling.

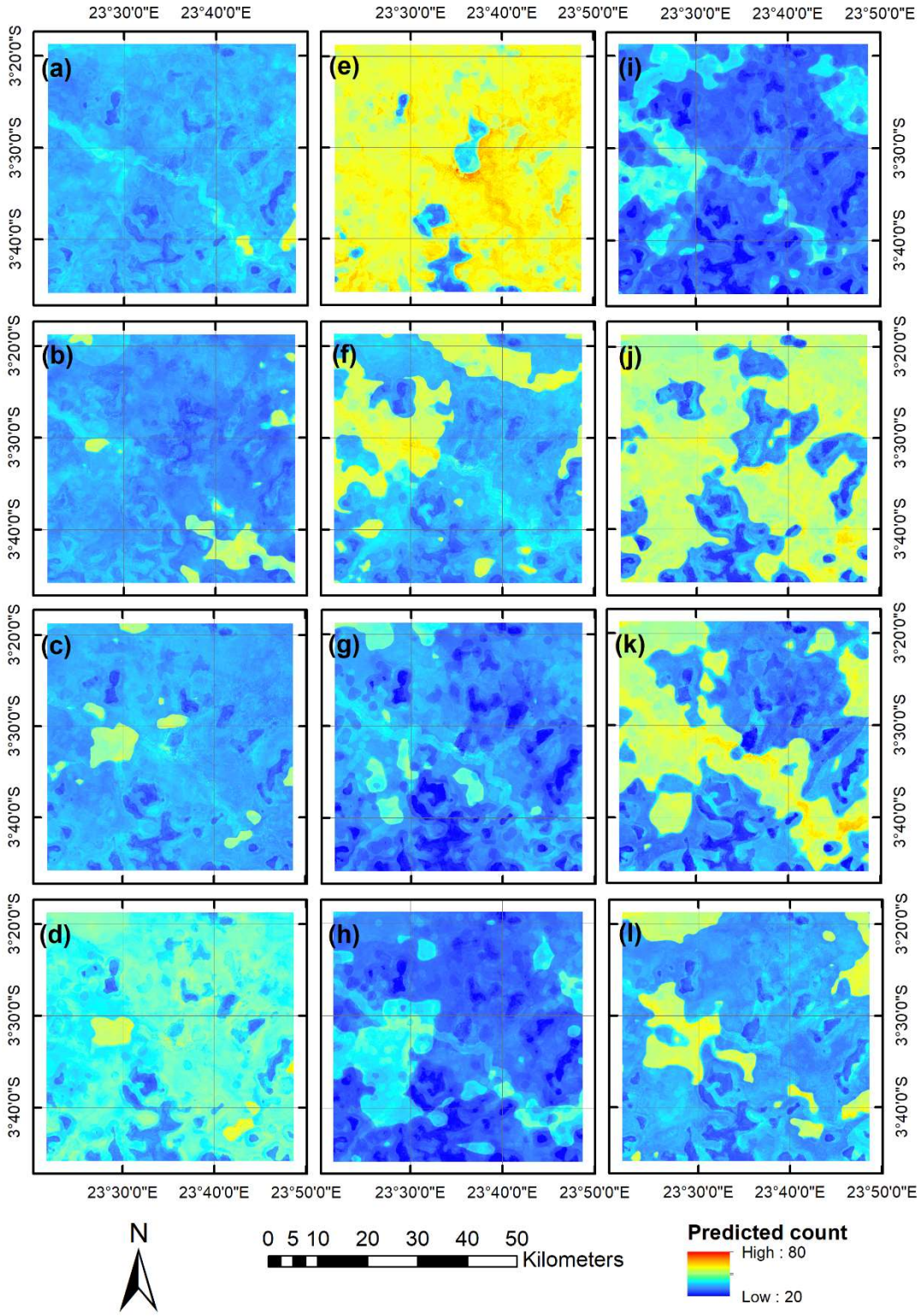

Figure S3. Predicted counts of *An. gambiae s.l.* for the Lodja study area for (**a**) January 2015; (**b**) February 2015; (**c**) March 2015; (**d**) April 2015; (**e**) May 2015; (**f**) June 2015; (**g**) July 2015, (**h**) August 2015; (**i**) September 2015; (**j**) October 2015; (**k**) November 2015; (**l**) December 2015.

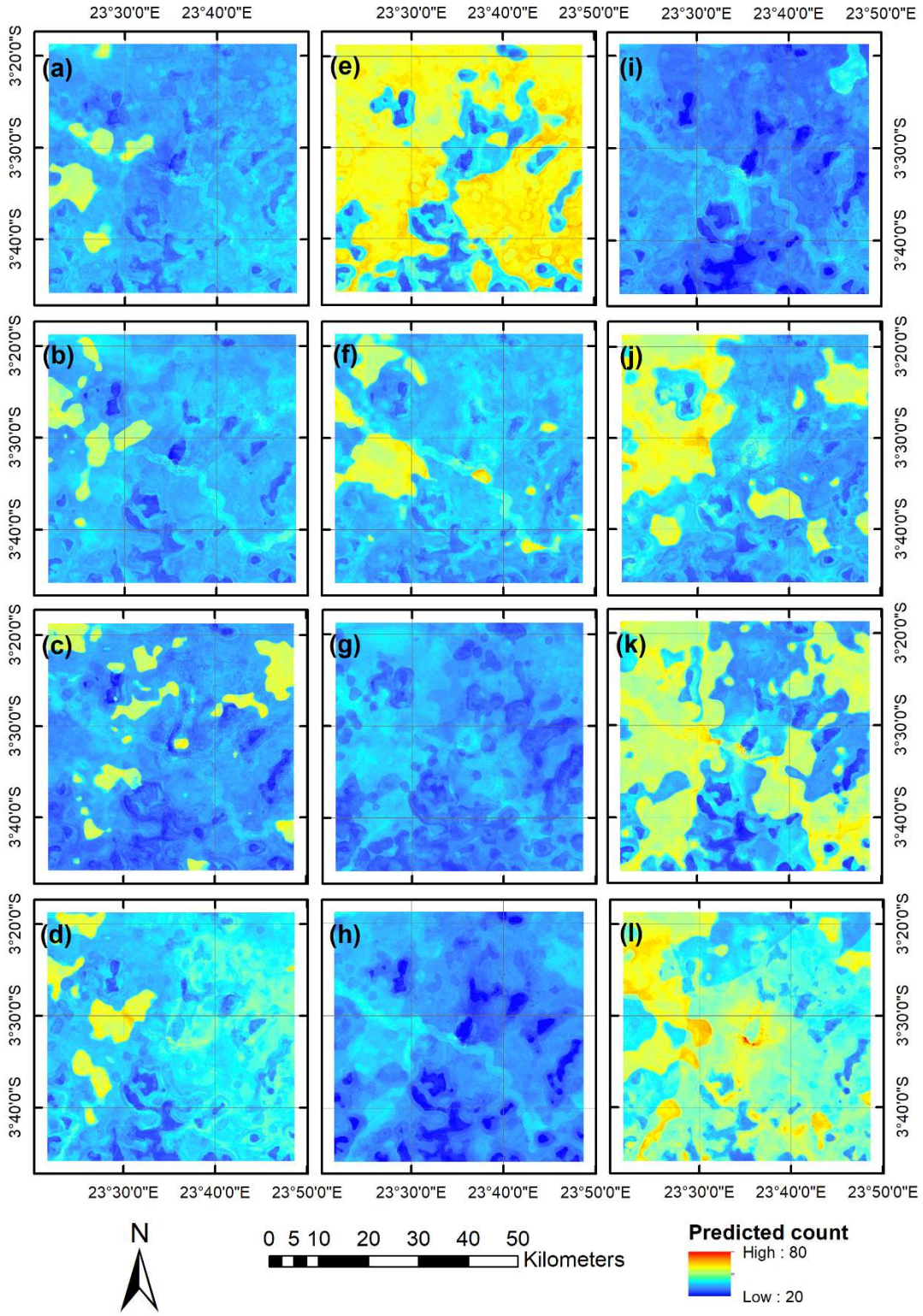

Figure S4. Predicted counts of *An. gambiae s.l.* for the Lodja study area for (**a**) January 2016; (**b**) February 2016; (**c**) March 2016; (**d**) April 2016; (**e**) May 2016; (**f**) June 2016; (**g**) July 2016, (**h**) August 2016; (**i**) September 2016; (**j**) October 2016; (**k**) November 2016; (**l**) December 2016.

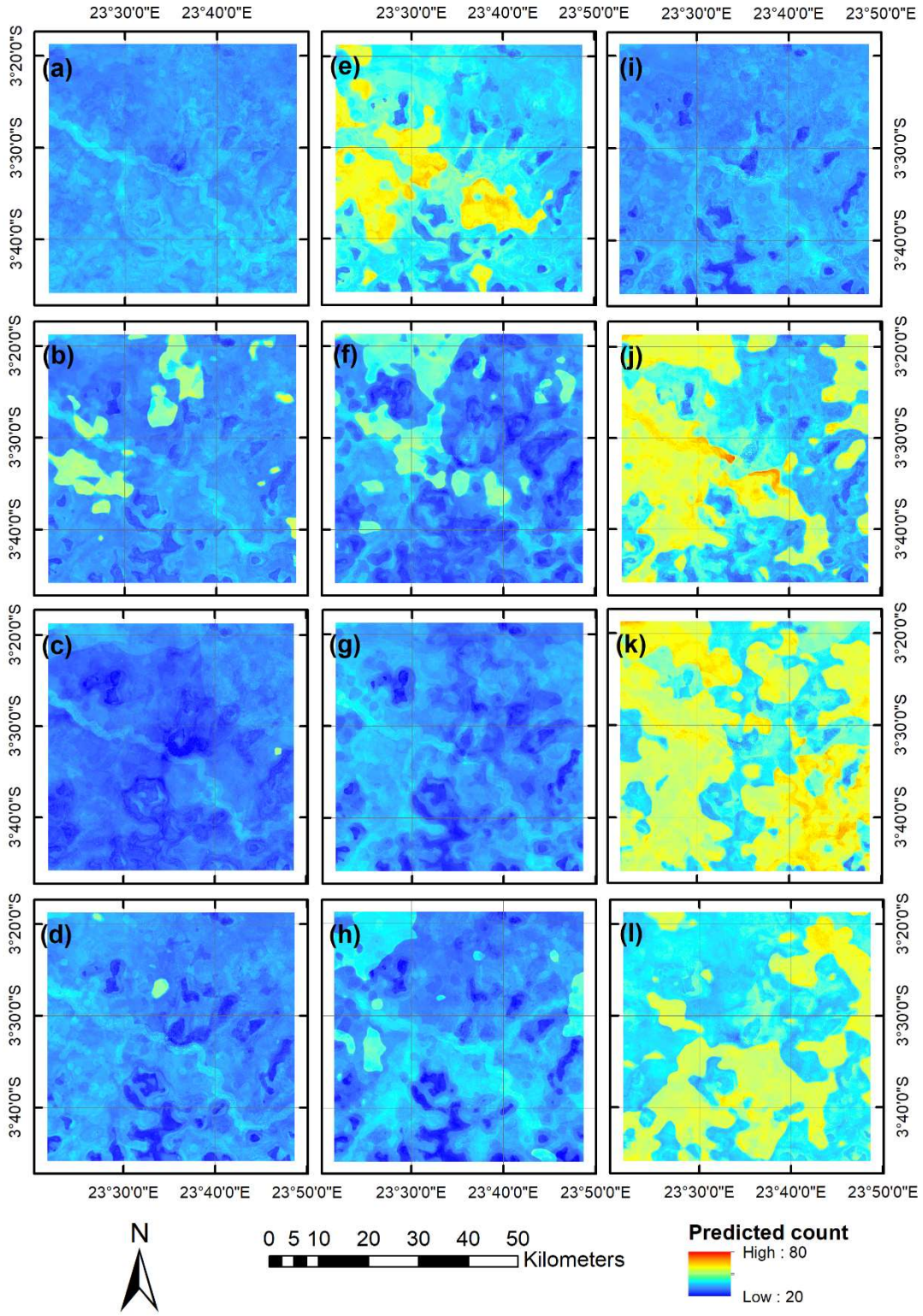

Figure S5. Predicted counts of *An. gambiae s.l.* for the Lodja study area for (**a**) January 2017; (**b**) February 2017; (**c**) March 2017; (**d**) April 2017; (**e**) May 2017; (**f**) June 2017; (**g**) July 2017, (**h**) August 2017; (**i**) September 2017; (**j**) October 2017; (**k**) November 2017; (**l**) December 2017.

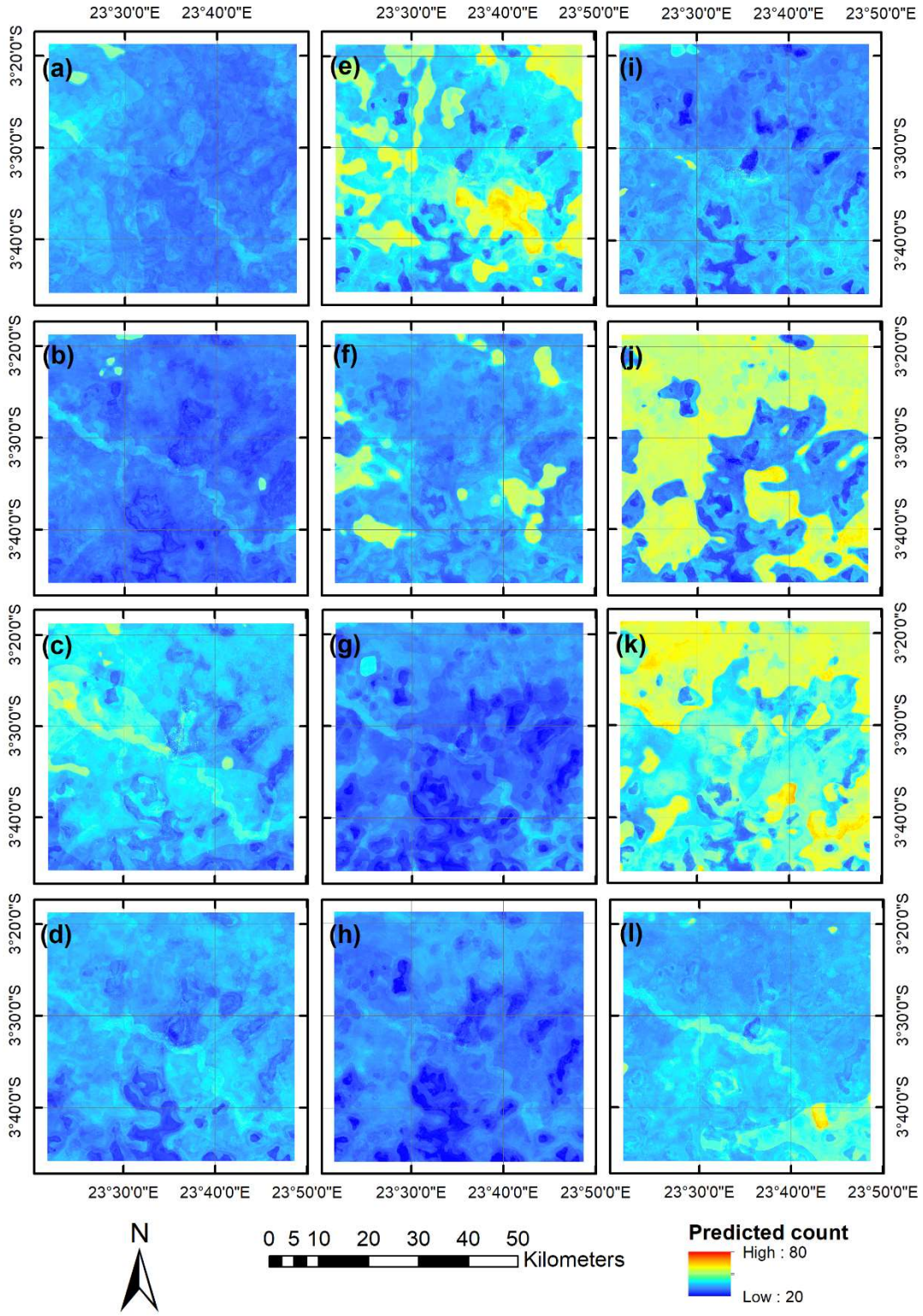

Figure S6. Predicted counts of *An. gambiae s.l.* for the Lodja study area for (**a**) January 2019; (**b**) February 2019; (**c**) March 2019; (**d**) April 2019; (**e**) May 2019; (**f**) June 2019; (**g**) July 2019, (**h**) August 2019; (**i**) September 2019; (**j**) October 2019; (**k**) November 2019; (**l**) December 2019.

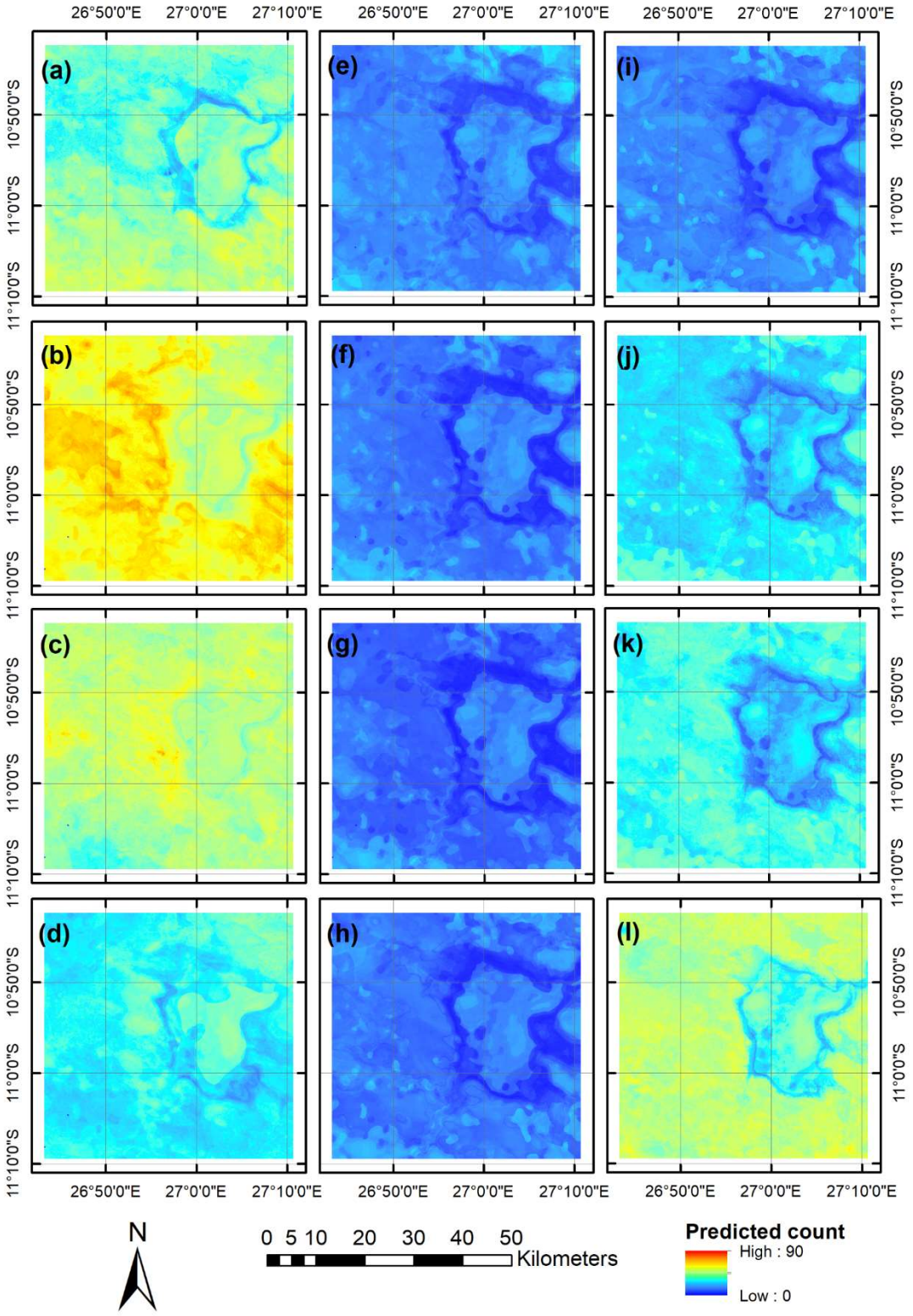

Figure S7. Predicted counts of *An. gambiae s.l.* for the Kapolowe study area for (**a**) January 2016; (**b**) February 2016; (**c**) March 2016; (**d**) April 2016; (**e**) May 2016; (**f**) June 2016; (**g**) July 2016, (**h**) August 2016; (**i**) September 2016; (**j**) October 2016; (**k**) November 2016; (**l**) December 2016.

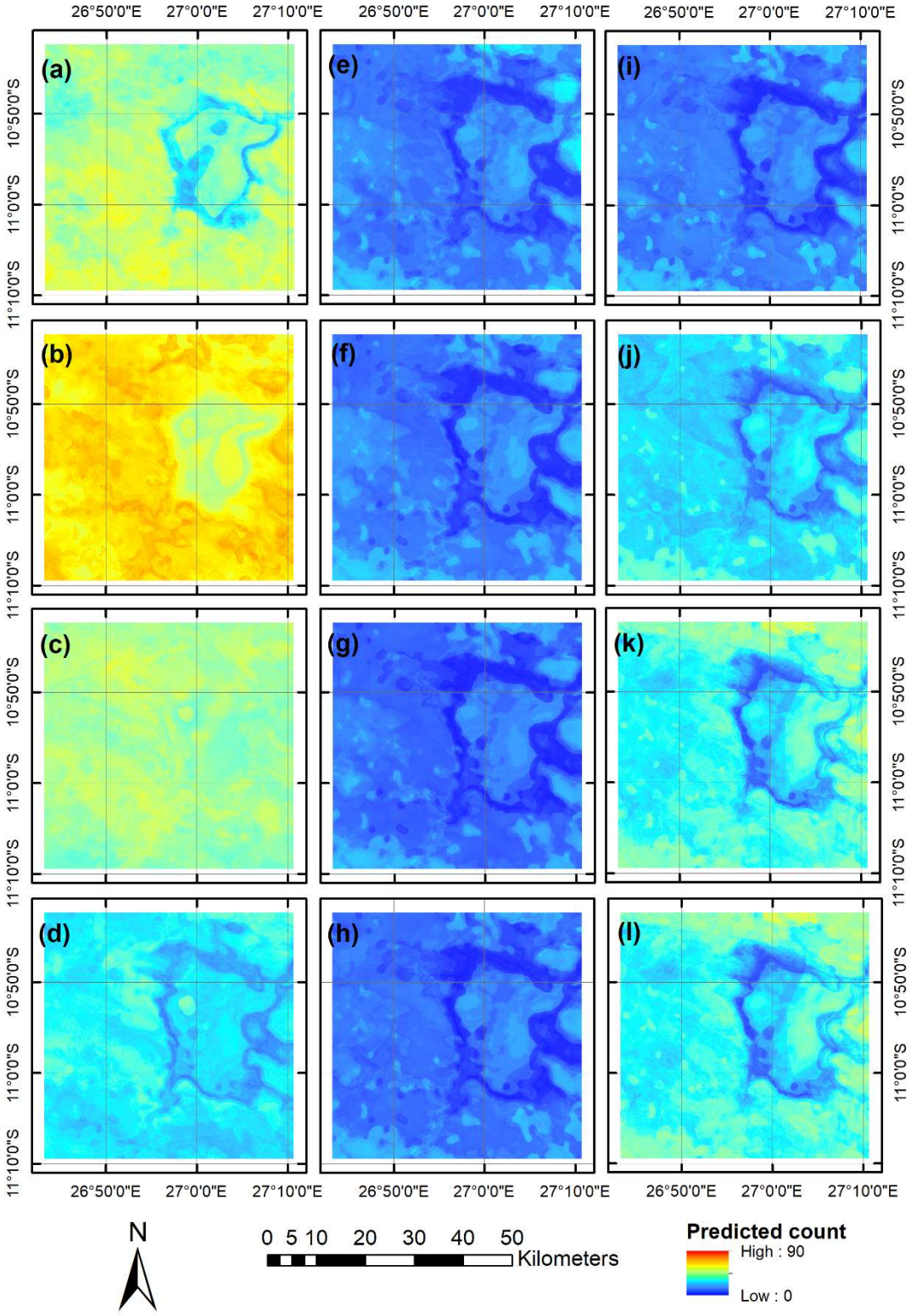

Figure S8. Predicted counts of *An. gambiae s.l.* for the Kapolowe study area for (**a**) January 2017; (**b**) February 2017; (**c**) March 2017; (**d**) April 2017; (**e**) May 2017; (**f**) June 2017; (**g**) July 2017, (**h**) August 2017; (**i**) September 2017; (**j**) October 2017; (**k**) November 2017; (**l**) December 2017.

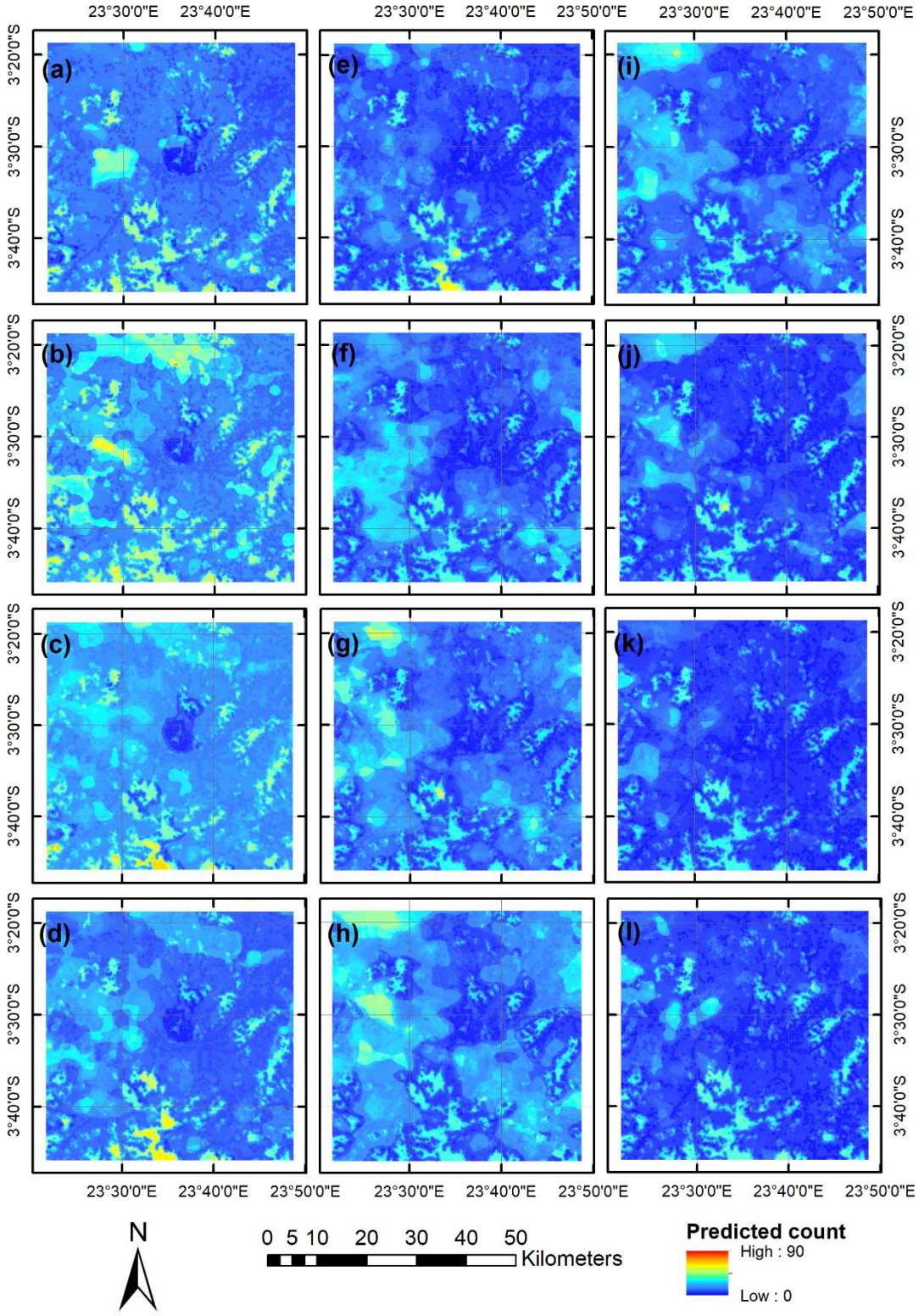

Figure S9. Predicted counts of *An. funestus* for the Lodja study area for (**a**) January 2015; (**b**) February 2015; (**c**) March 2015; (**d**) April 2015; (**e**) May 2015; (**f**) June 2015; (**g**) July 2015, (**h**) August 2015; (**i**) September 2015; (**j**) October 2015; (**k**) November 2015; (**l**) December 2015.

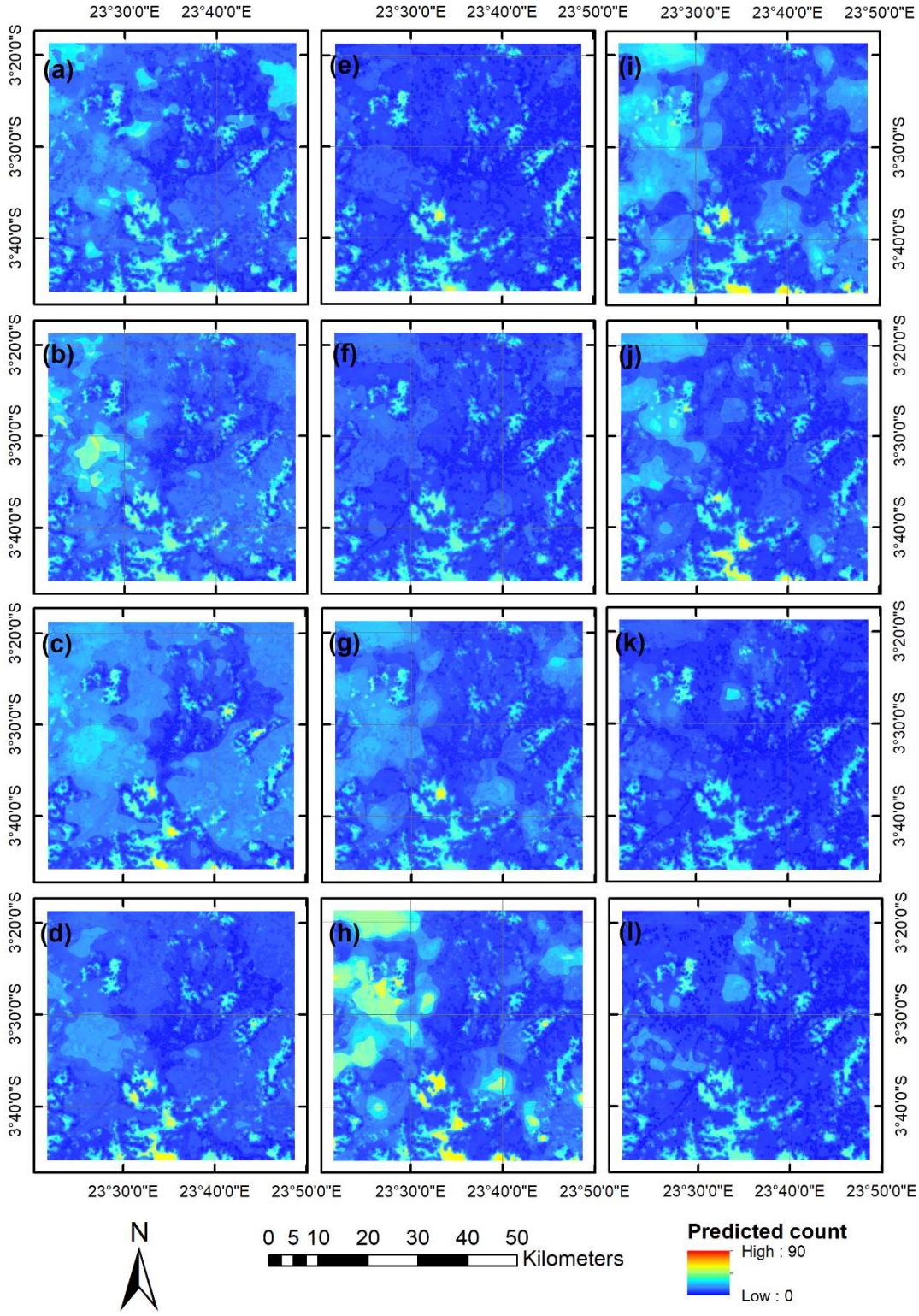

Figure S10. Predicted counts of *An. funestus* for the Lodja study area for (**a**) January 2016; (**b**) February 2016; (**c**) March 2016; (**d**) April 2016; (**e**) May 2016; (**f**) June 2016; (**g**) July 2016, (**h**) August 2016; (**i**) September 2016; (**j**) October 2016; (**k**) November 2016; (**l**) December 2016.

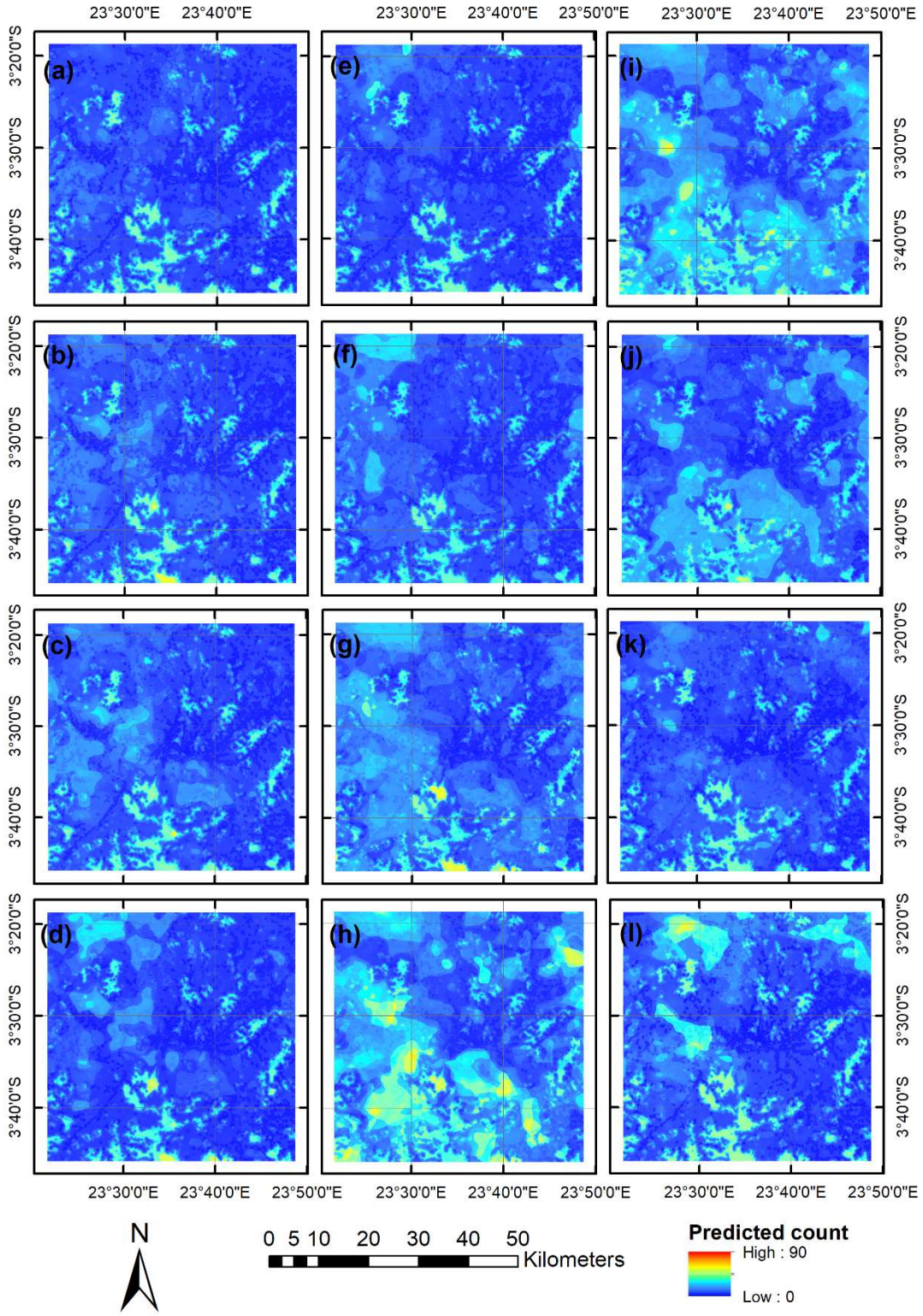

Figure S11. Predicted counts of *An. funestus* for the Lodja study area for (**a**) January 2017; (**b**) February 2017; (**c**) March 2017; (**d**) April 2017; (**e**) May 2017; (**f**) June 2017; (**g**) July 2017, (**h**) August 2017; (**i**) September 2017; (**j**) October 2017; (**k**) November 2017; (**l**) December 2017.

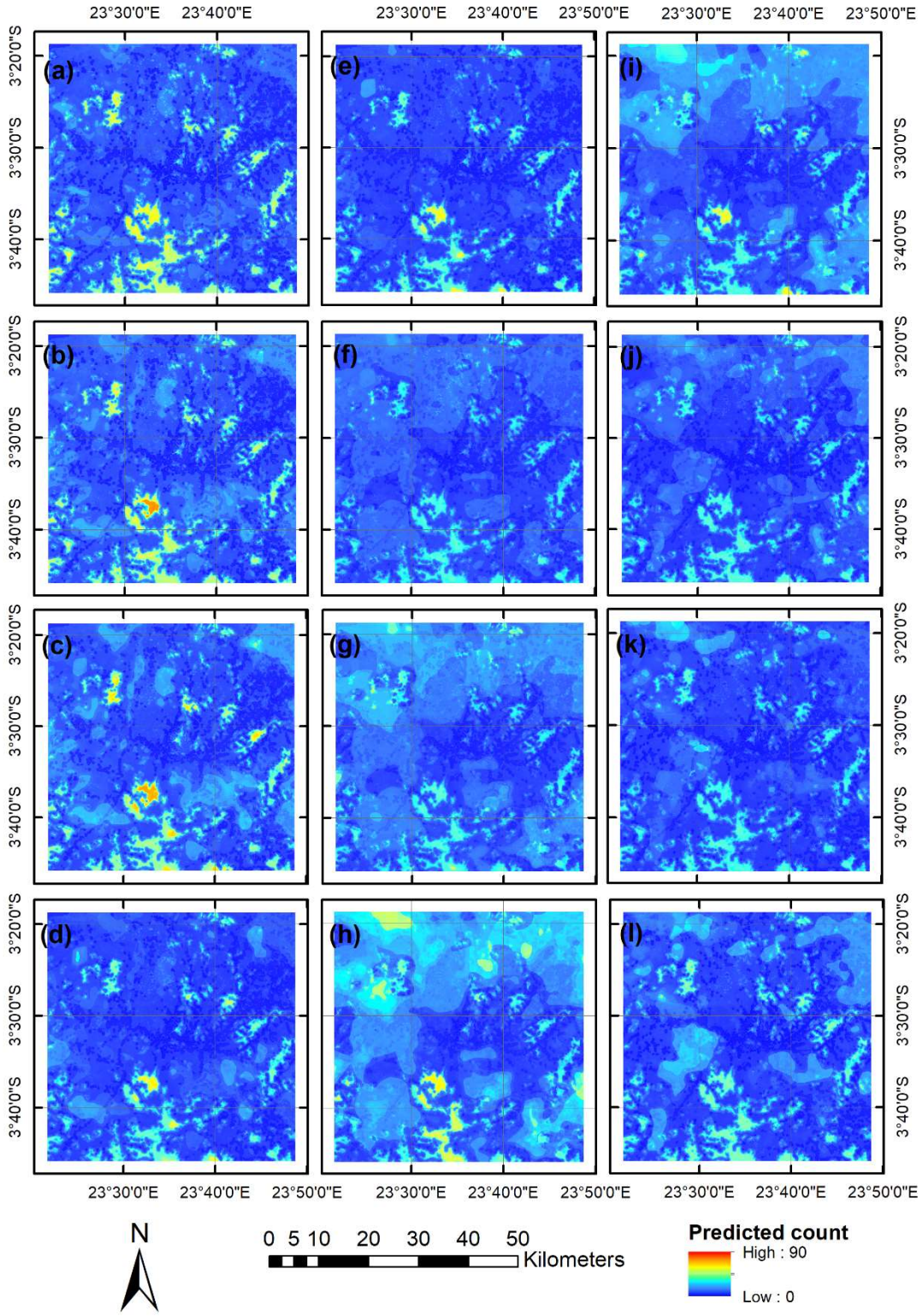

Figure S12. Predicted counts of *An. funestus* for the Lodja study area for (**a**) January 2019; (**b**) February 2019; (**c**) March 2019; (**d**) April 2019; (**e**) May 2019; (**f**) June 2019; (**g**) July 2019, (**h**) August 2019; (**i**) September 2019; (**j**) October 2019; (**k**) November 2019; (**l**) December 2019.

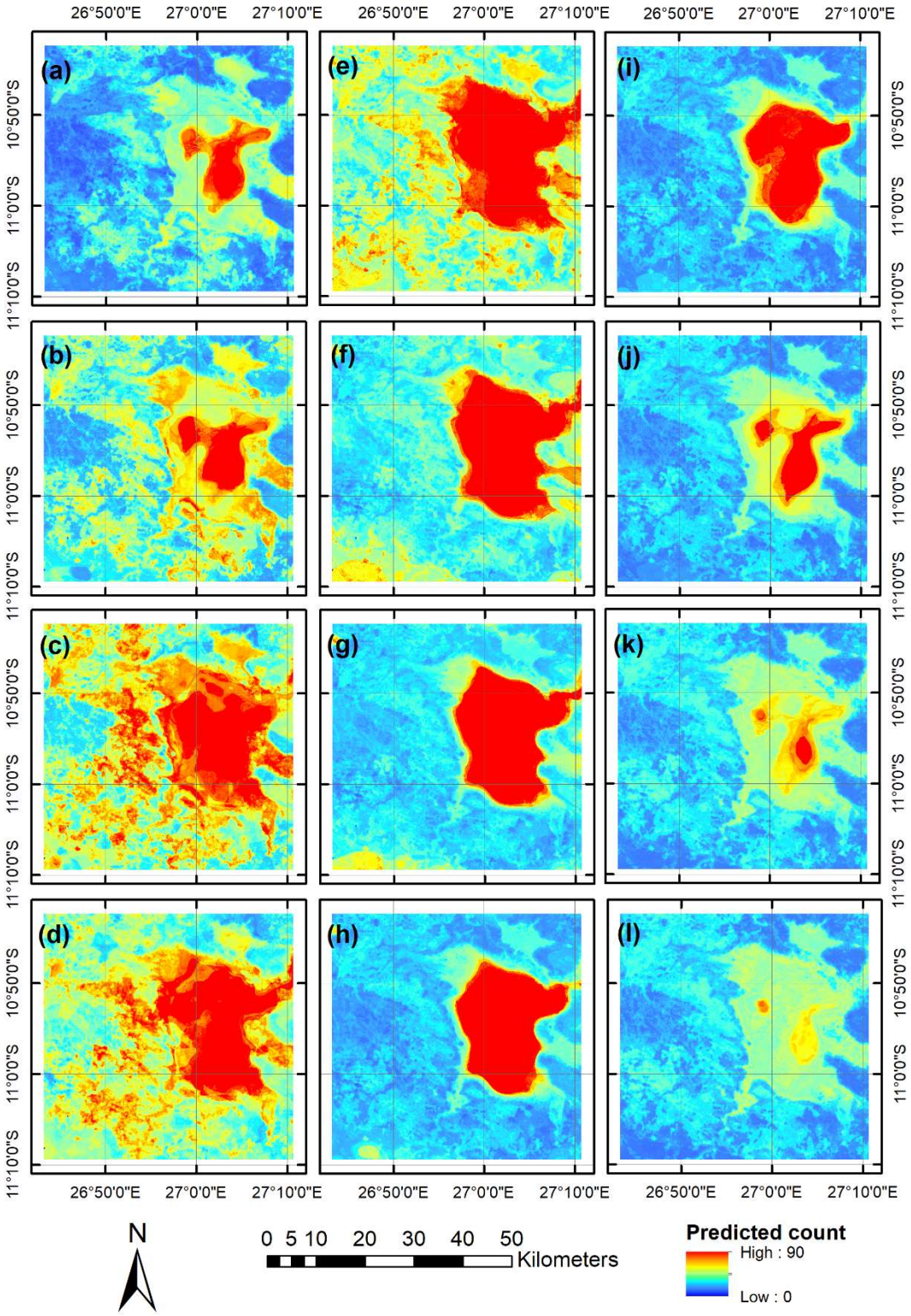

Figure S13. Predicted counts of *An. funestus* for the Kapolowe study area for (**a**) January 2016; (**b**) February 2016; (**c**) March 2016; (**d**) April 2016; (**e**) May 2016; (**f**) June 2016; (**g**) July 2016, (**h**) August 2016; (**i**) September 2016; (**j**) October 2016; (**k**) November 2016; (**l**) December 2016.

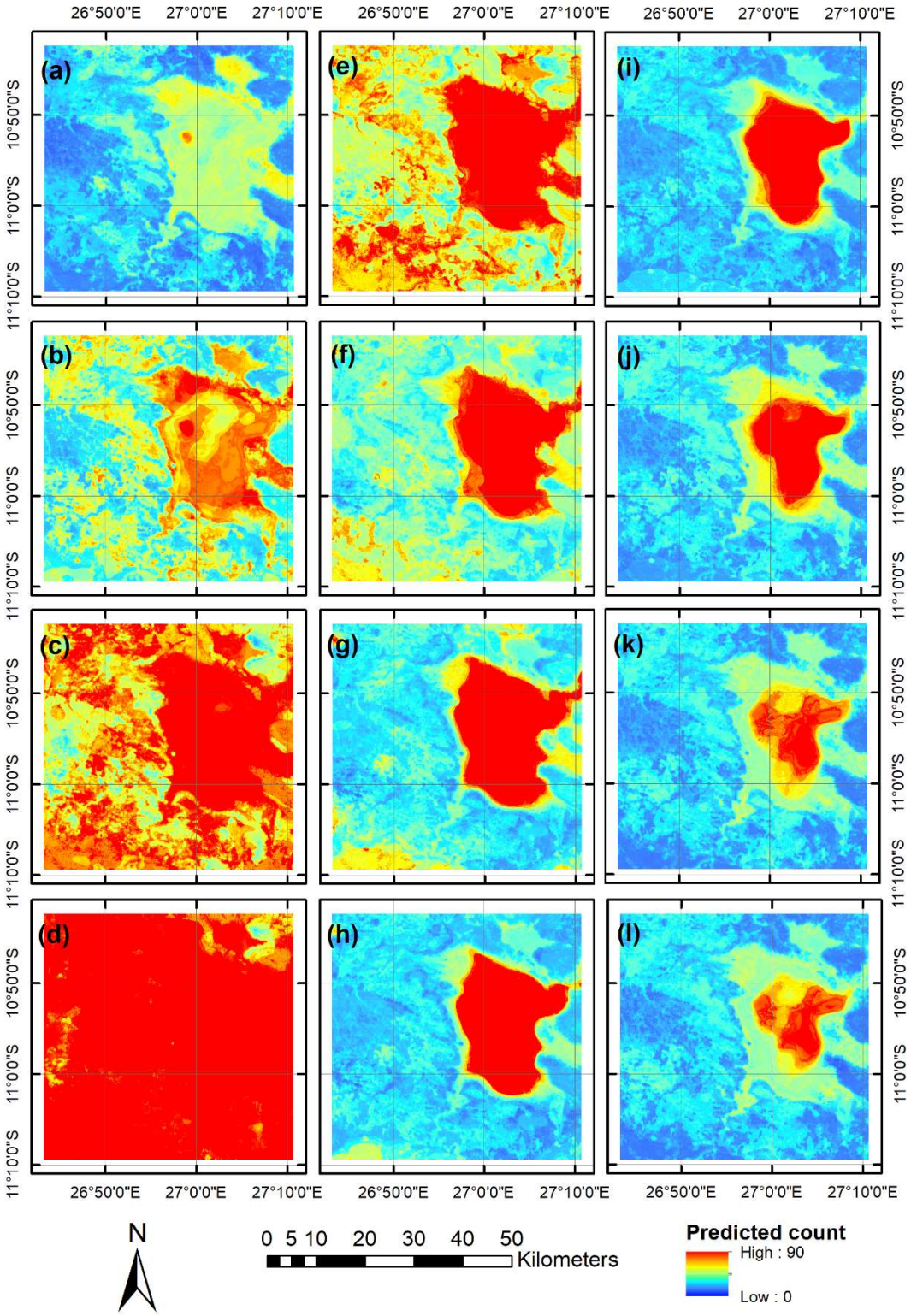

Figure S14. Predicted counts of *An. funestus* for the Kapolowe study area for (**a**) January 2017; (**b**) February 2017; (**c**) March 2017; (**d**) April 2017; (**e**) May 2017; (**f**) June 2017; (**g**) July 2017, (**h**) August 2017; (**i**) September 2017; (**j**) October 2017; (**k**) November 2017; (**l**) December 2017.

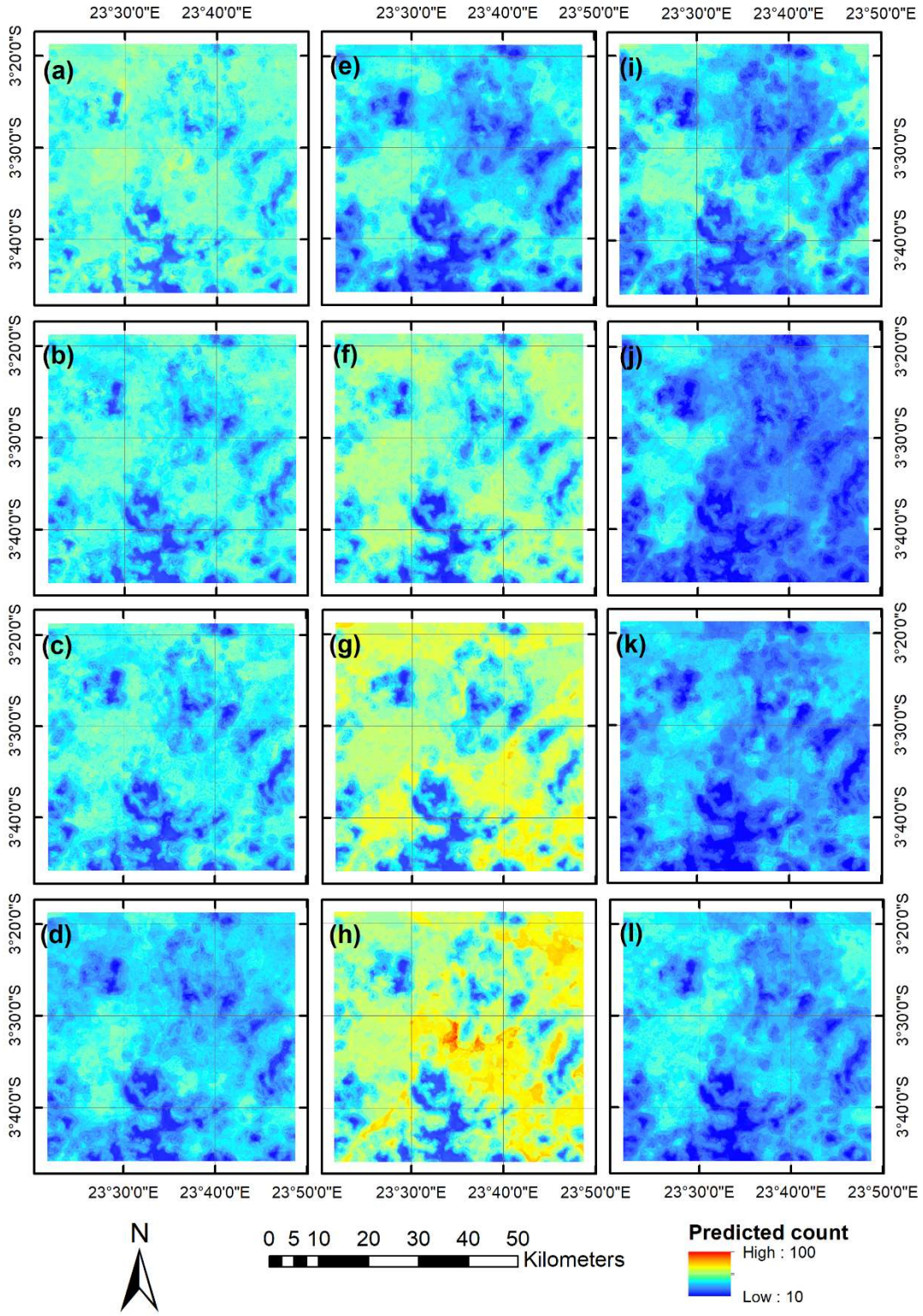

Figure S15. Predicted counts of *An. paludis* for the Lodja study area for (**a**) January 2015; (**b**) February 2015; (**c**) March 2015; (**d**) April 2015; (**e**) May 2015; (**f**) June 2015; (**g**) July 2015, (**h**) August 2015; (**i**) September 2015; (**j**) October 2015; (**k**) November 2015; (**l**) December 2015.

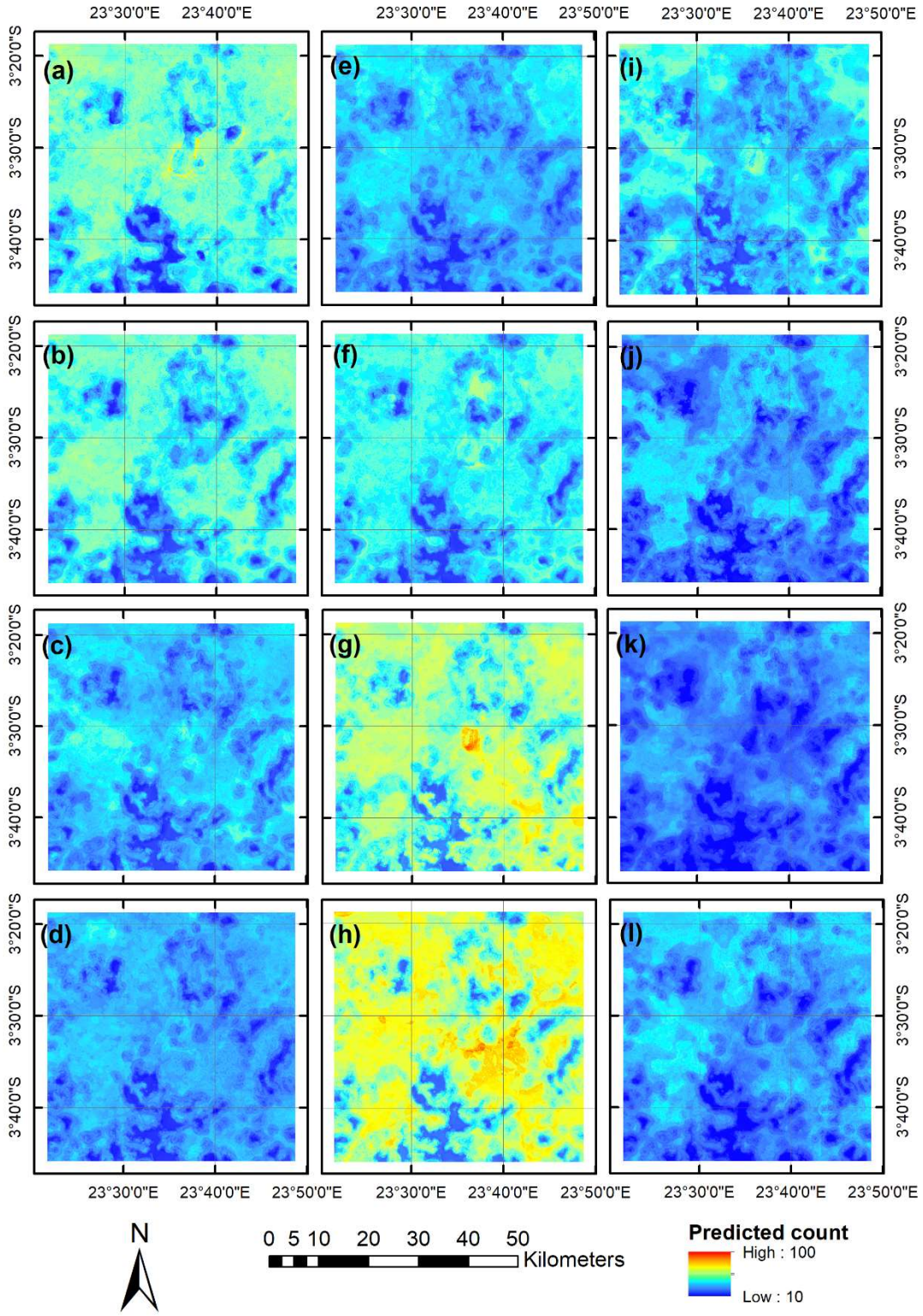

Figure S16. Predicted counts of *An. paludis* for the Lodja study area for (**a**) January 2016; (**b**) February 2016; (**c**) March 2016; (**d**) April 2016; (**e**) May 2016; (**f**) June 2016; (**g**) July 2016, (**h**) August 2016; (**i**) September 2016; (**j**) October 2016; (**k**) November 2016; (**l**) December 2016.

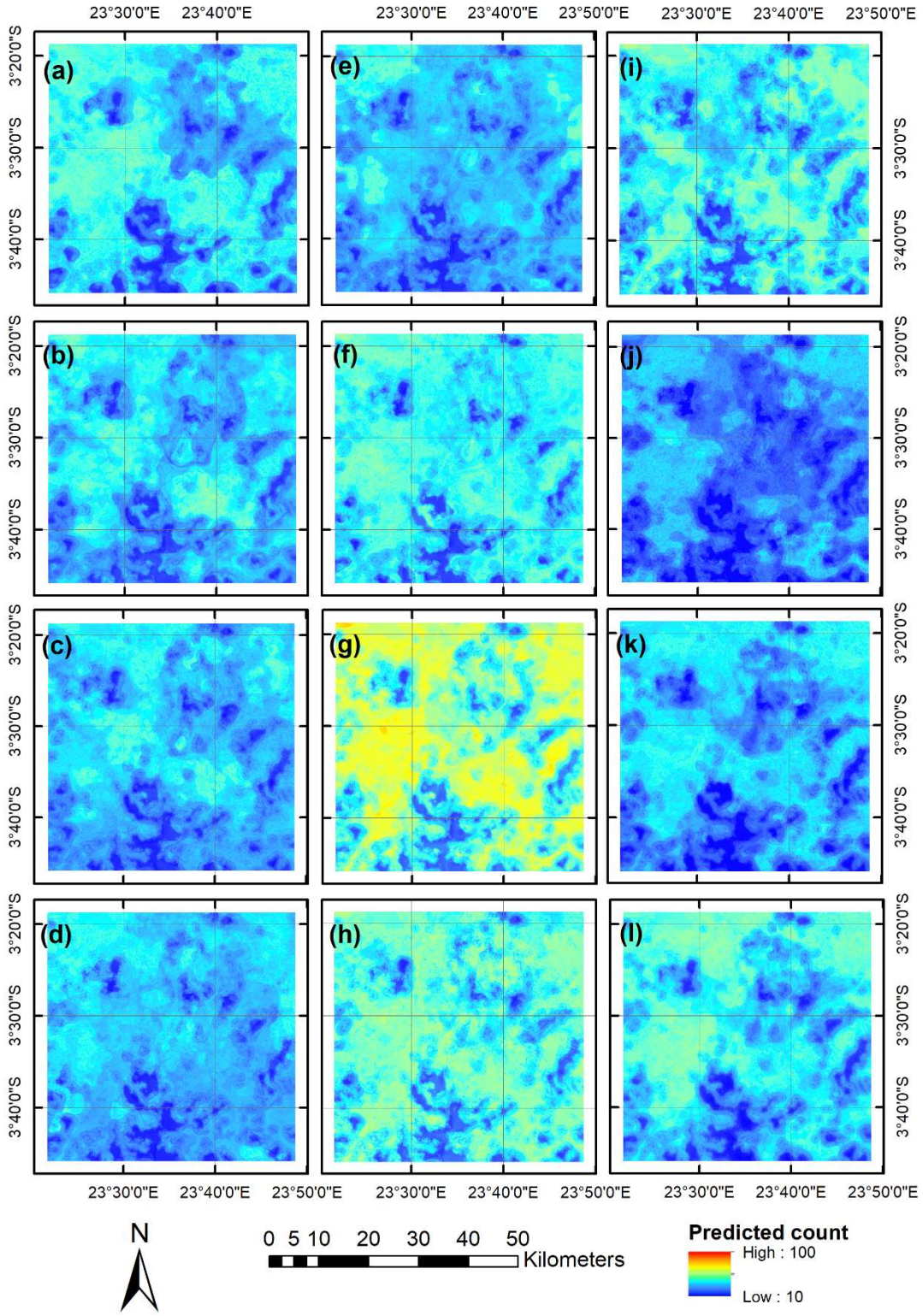

Figure S17. Predicted counts of *An. paludis* for the Lodja study area for (**a**) January 2017; (**b**) February 2017; (**c**) March 2017; (**d**) April 2017; (**e**) May 2017; (**f**) June 2017; (**g**) July 2017, (**h**) August 2017; (**i**) September 2017; (**j**) October 2017; (**k**) November 2017; (**l**) December 2017.

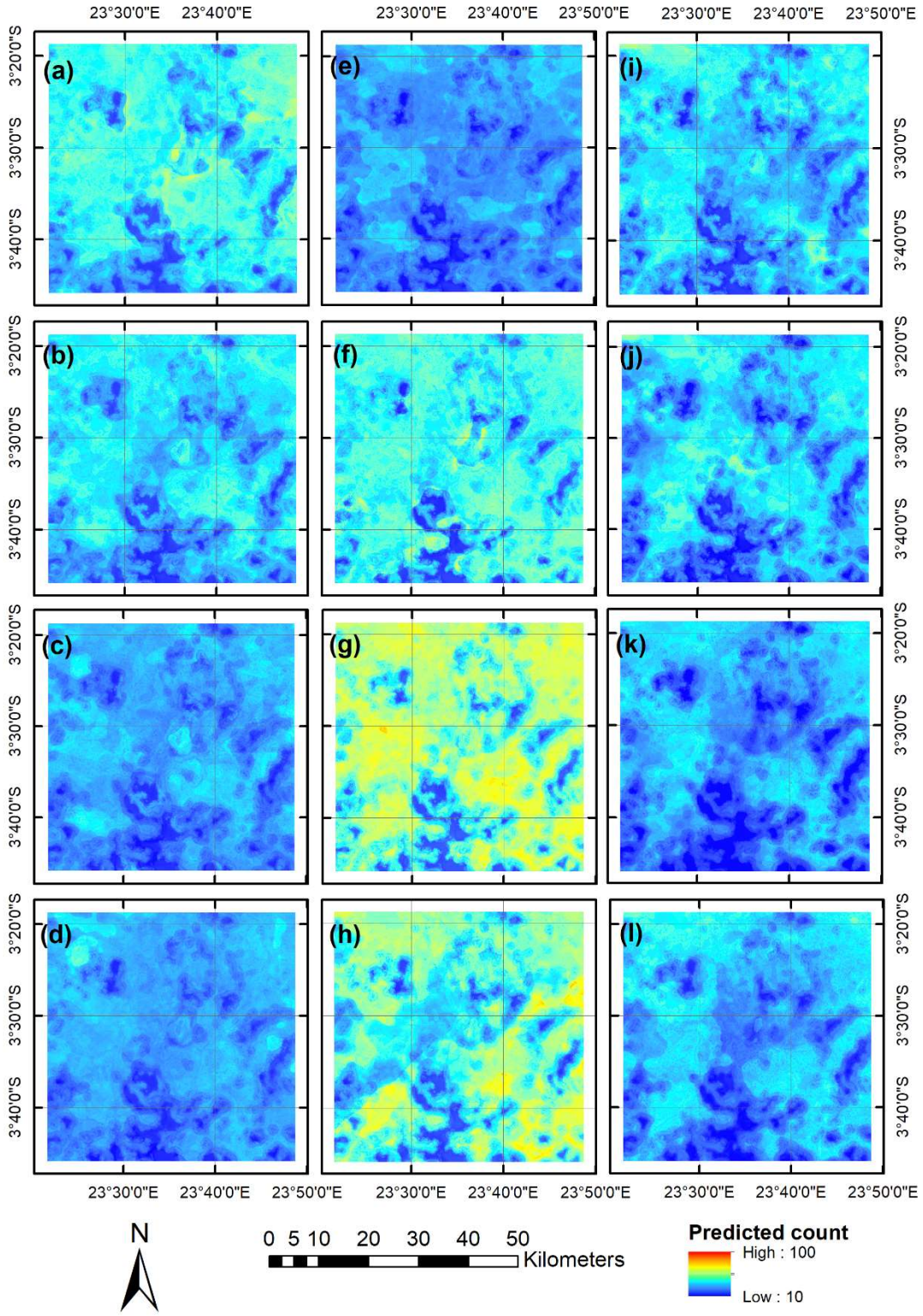

Figure S18. Predicted counts of *An. paludis* for the Lodja study area for (**a**) January 2019; (**b**) February 2019; (**c**) March 2019; (**d**) April 2019; (**e**) May 2019; (**f**) June 2019; (**g**) July 2019, (**h**) August 2019; (**i**) September 2019; (**j**) October 2019; (**k**) November 2019; (**l**) December 2019.

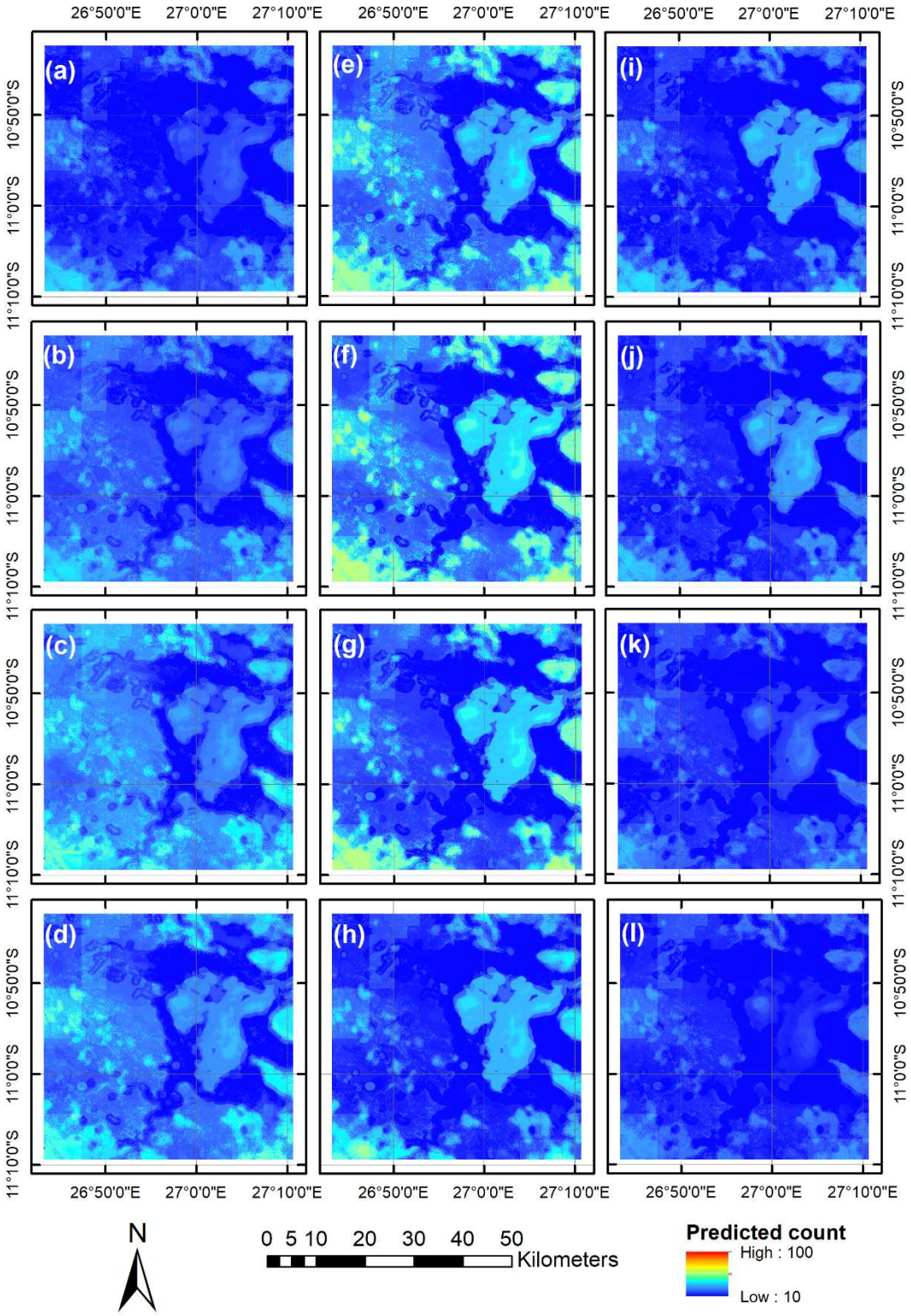

Figure S19. Predicted counts of *An. paludis* for the Kapolowe study area for (**a**) January 2016; (**b**) February 2016; (**c**) March 2016; (**d**) April 2016; (**e**) May 2016; (**f**) June 2016; (**g**) July 2016, (**h**) August 2016; (**i**) September 2016; (**j**) October 2016; (**k**) November 2016; (**l**) December 2016.

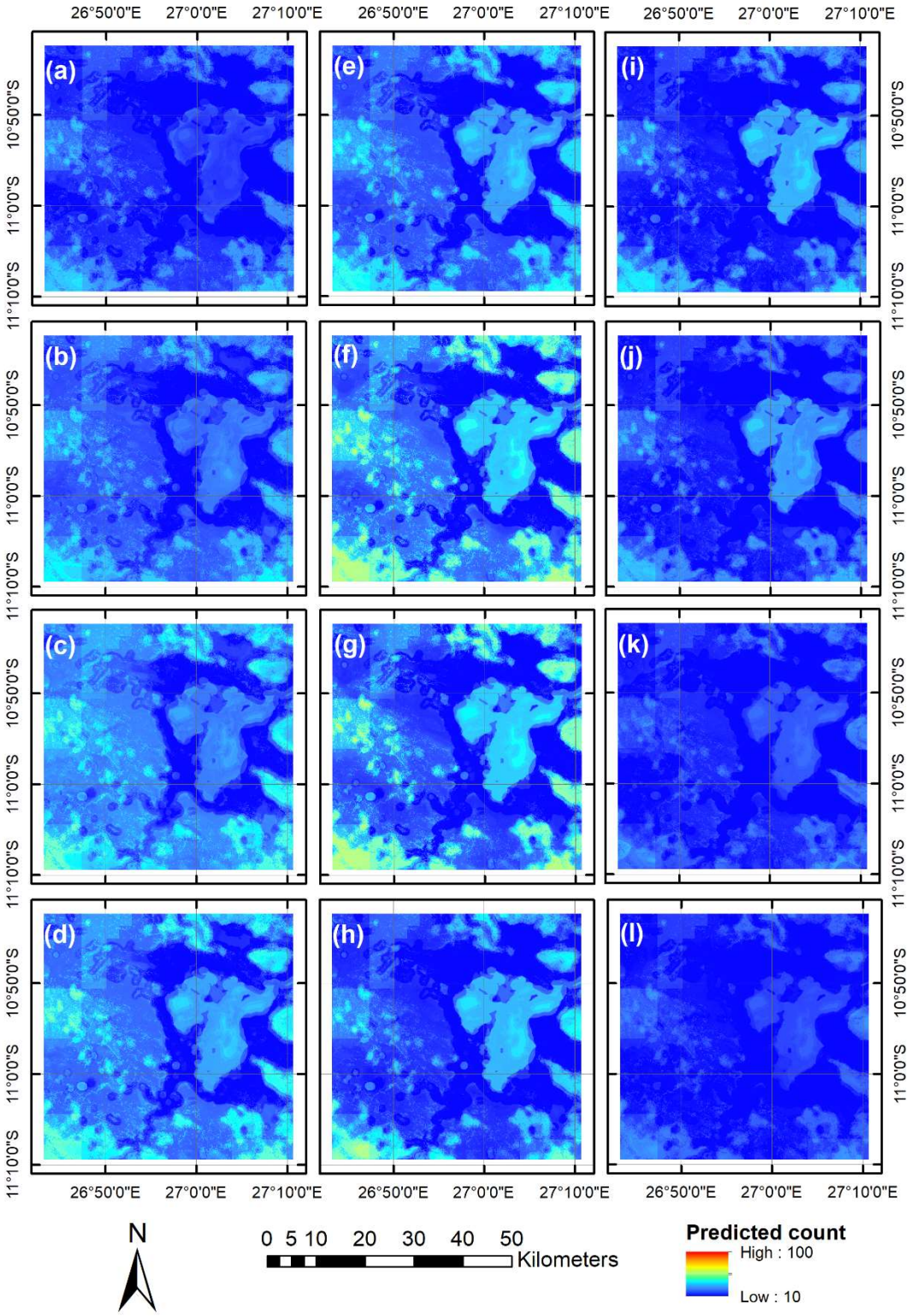

Figure S20. Predicted counts of *An. paludis* for the Kapolowe study area for (**a**) January 2017; (**b**) February 2017; (**c**) March 2017; (**d**) April 2017; (**e**) May 2017; (**f**) June 2017; (**g**) July 2017, (**h**) August 2017; (**i**) September 2017; (**j**) October 2017; (**k**) November 2017; (**l**) December 2017.