Supplementary figures S1-S8

Supplementary Figure S1

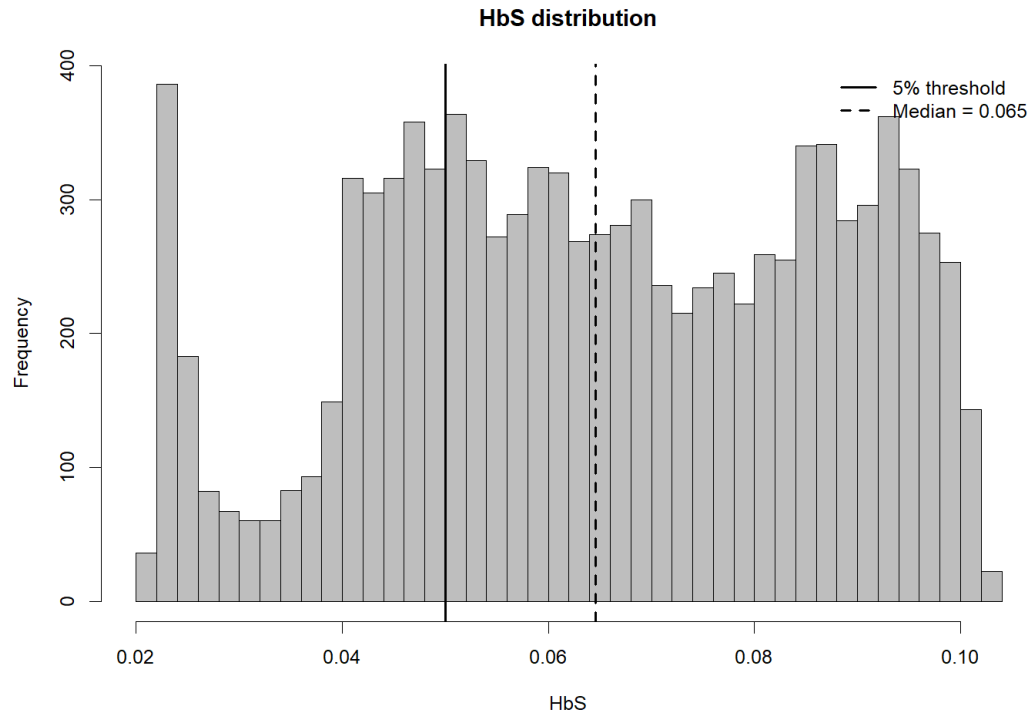

Figure S1. Distribution of HbS values. Histogram of pixelwise HbS on the 5 km grid with vertical lines at the 5% program threshold (solid) and the national median (dashed). Summary: median = 0.065; IQR = 0.048–0.085; 72.2% of pixels ≥ 0.05.

Supplementary Figure S2

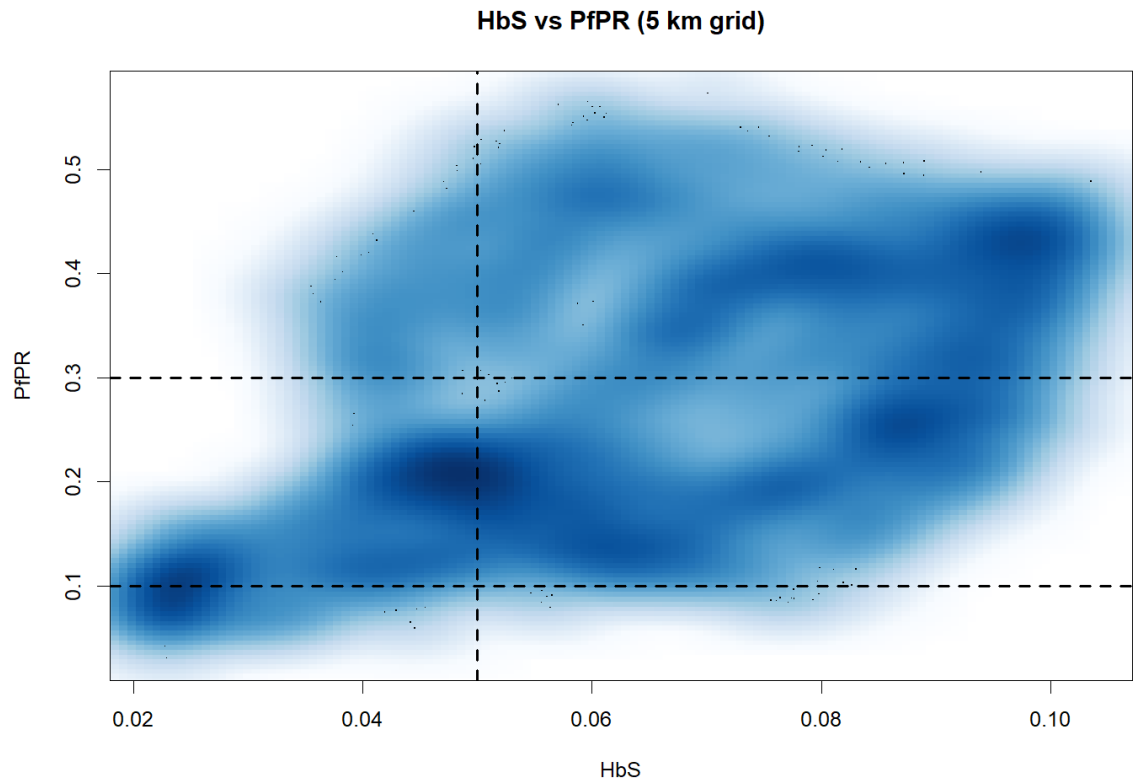

Figure S2. HbS vs PfPR. Smoothed bivariate scatter of paired HbS and PfPR pixels on the 5 km grid with reference lines at HbS 0.05 and PfPR 0.10 and 0.30

Supplementary Figure S3

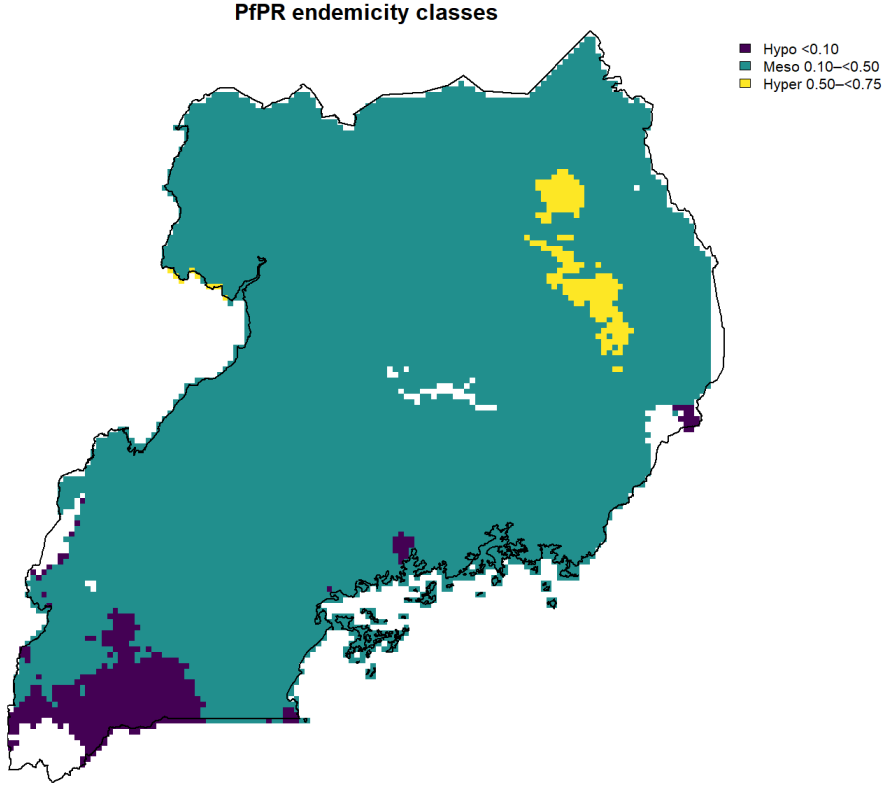

Figure S3. PfPR endemicity classes (classical bands). PfPR decade mean reclassified into hypo (<0.10), meso (0.10–<0.50), hyper (0.50–<0.75), and holo (≥0.75) on the 5 km grid. National area shares: 4.5% hypo, 88.0% meso, 1.9% hyper, 0.0% holo.

Supplementary Figure S4

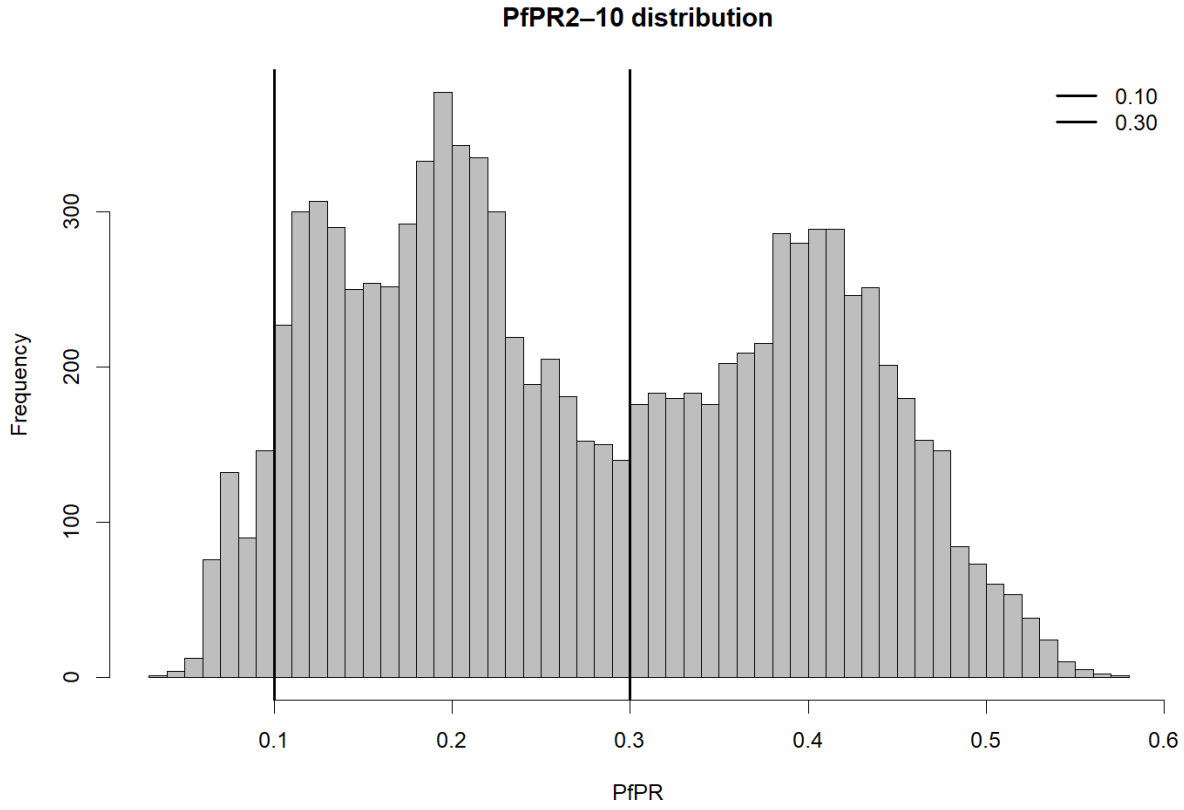

Figure S4. PfPR distribution with program cutoffs. Histogram of PfPR decade-mean pixel values; vertical lines at 0.10 and 0.30 illustrate canonical and programmatic thresholds. (By area, 100% of land is ≥ 0.30 on this dataset.)

Supplementary Figure S5

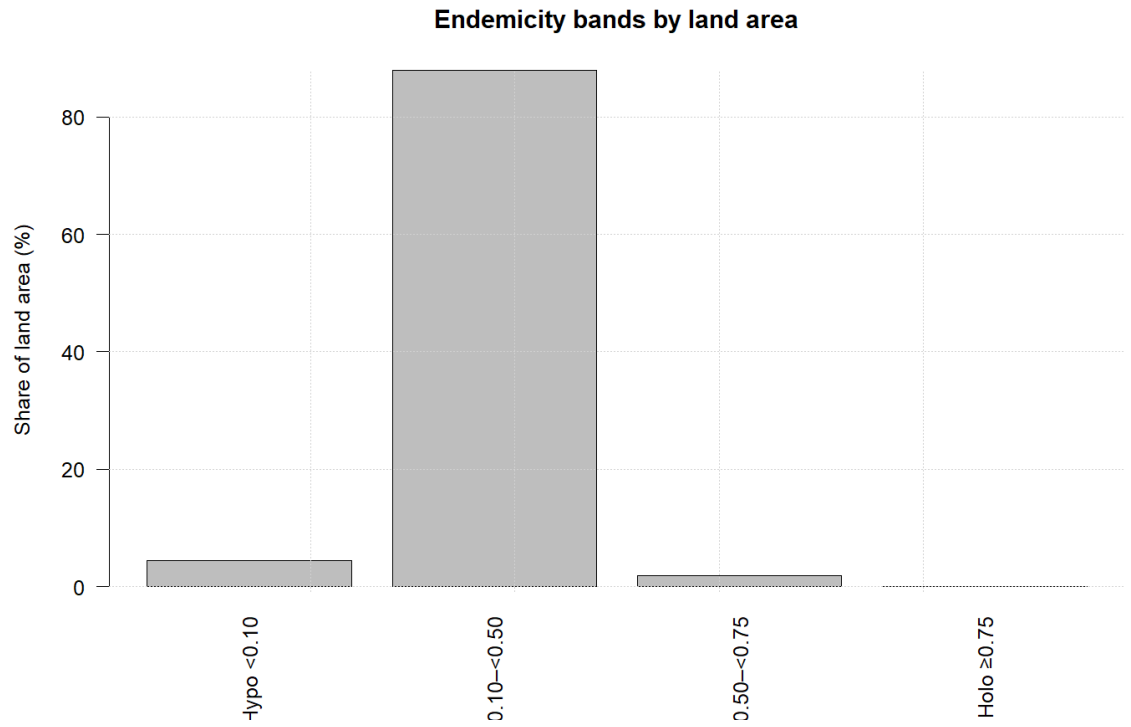

Figure S5. Endemicity bands by land area. Bar chart of national land-area share in each endemicity class derived from Figure 3B (4.5% hypo; 88.0% meso; 1.9% hyper; 0.0% holo).

Supplementary Figure S6

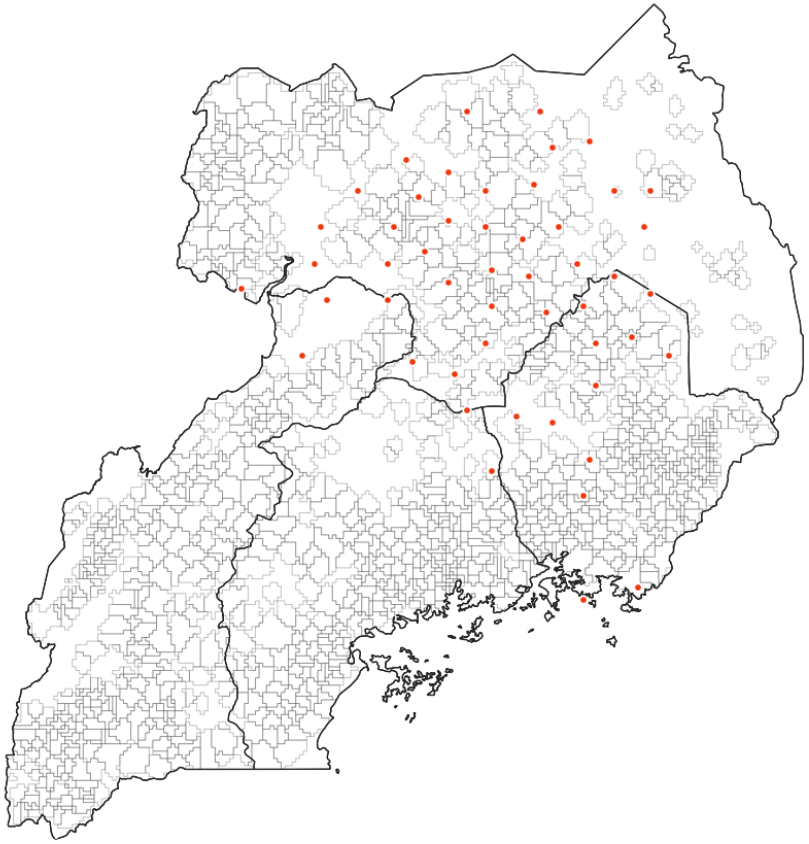

Figure S6. Matching of the 50 proposed screening sites from the HbS × PfPR prioritization to the national facility network using the 60-minute travel-time catchments

Supplementary Figure S7

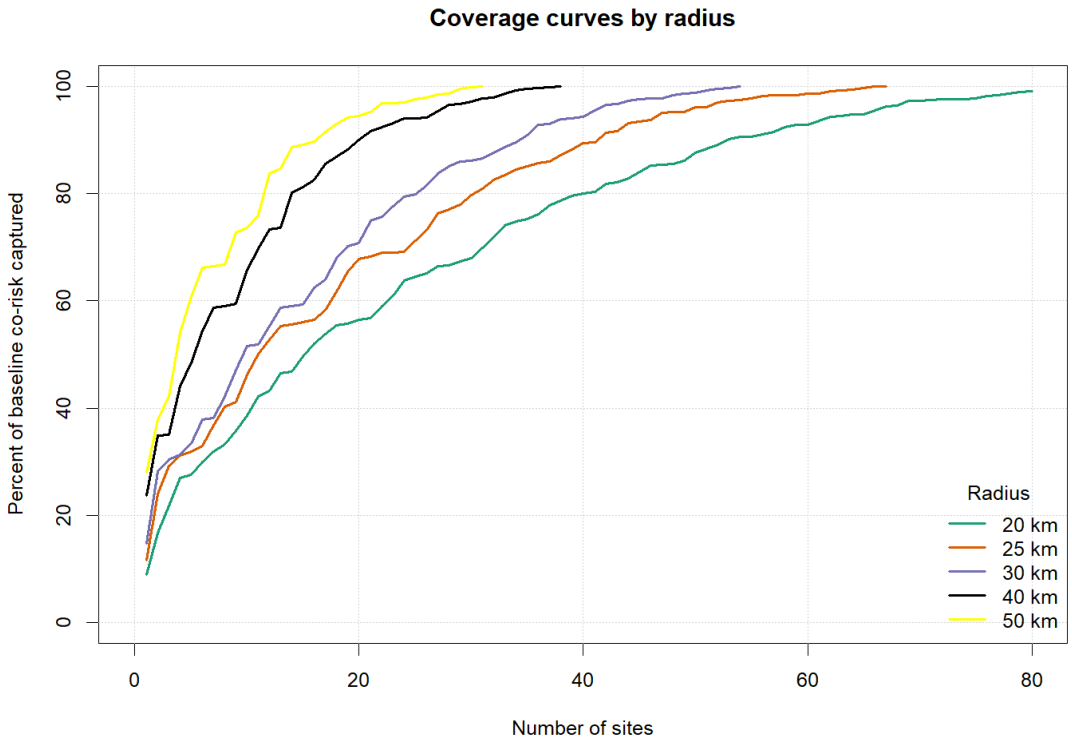

Figure S7. Coverage curves by radius (Percent of baseline co-risk captured for radii of 20, 25, 30, 40, and 50 km).

Supplementary Figure S8A-S8D

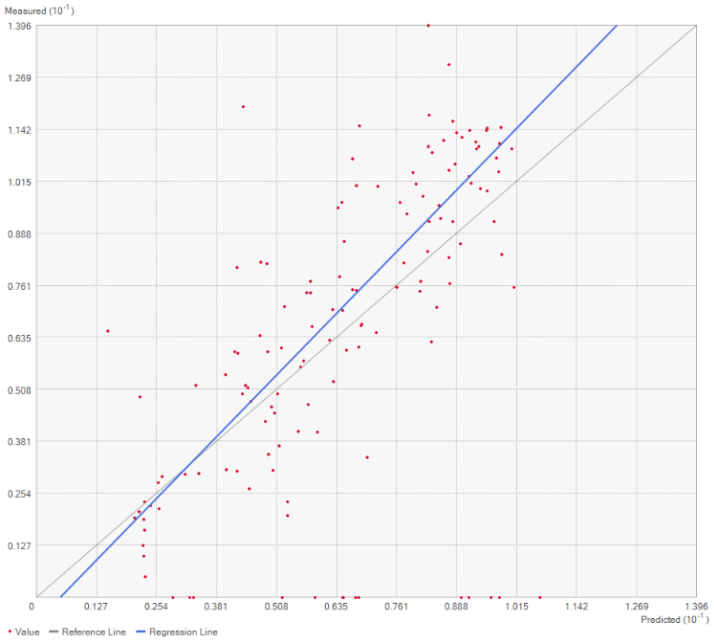

Figure S8A. Observed vs predicted with 1:1 reference and fitted regression;

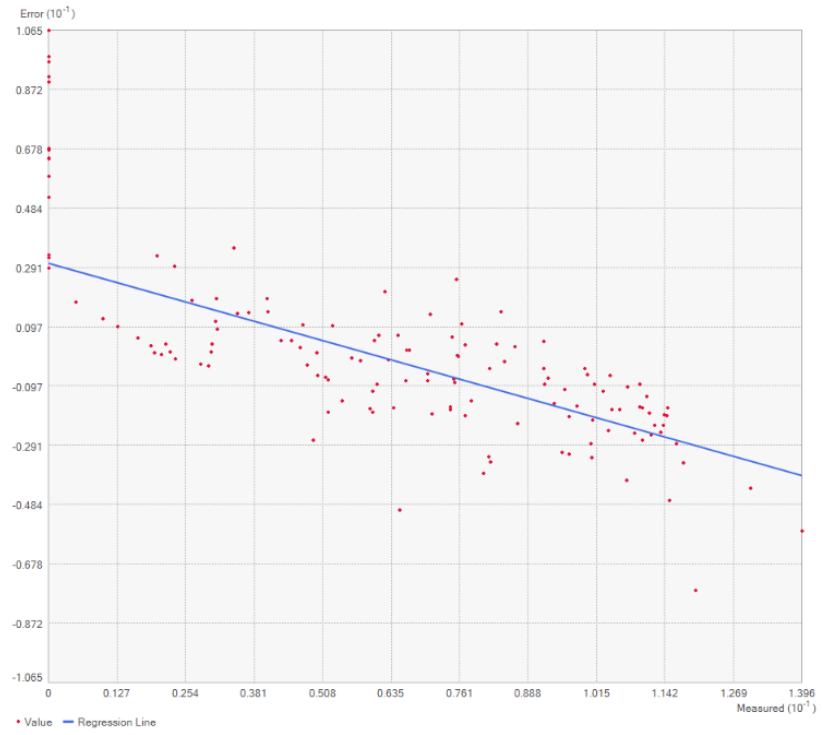

Figure S8B. Residual error vs measured;

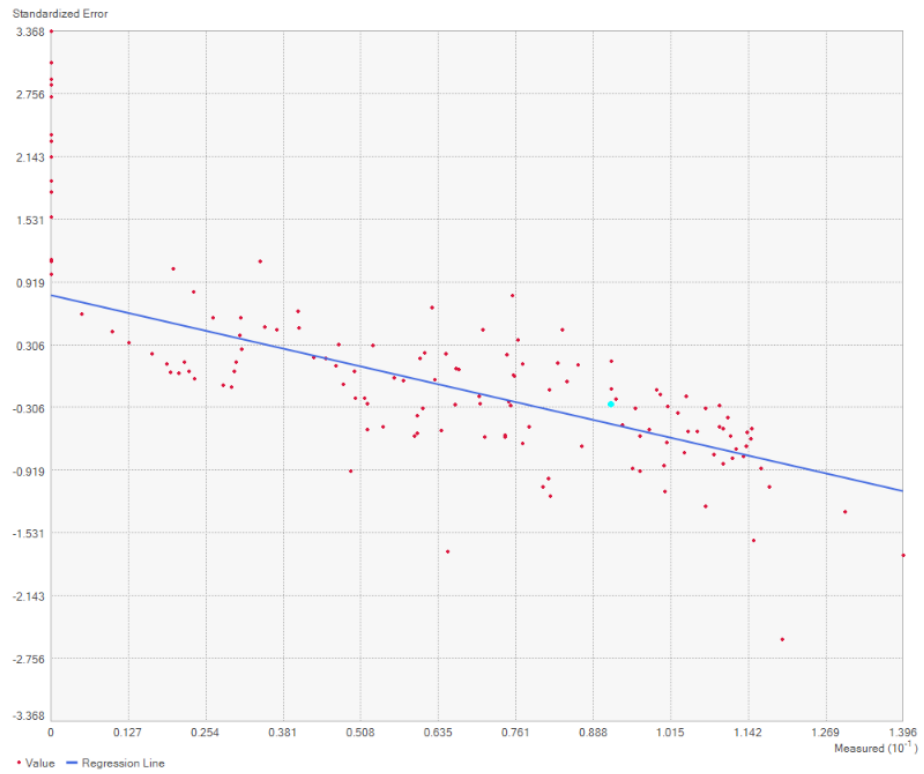

Figure S8C. Standardized residuals vs measured;

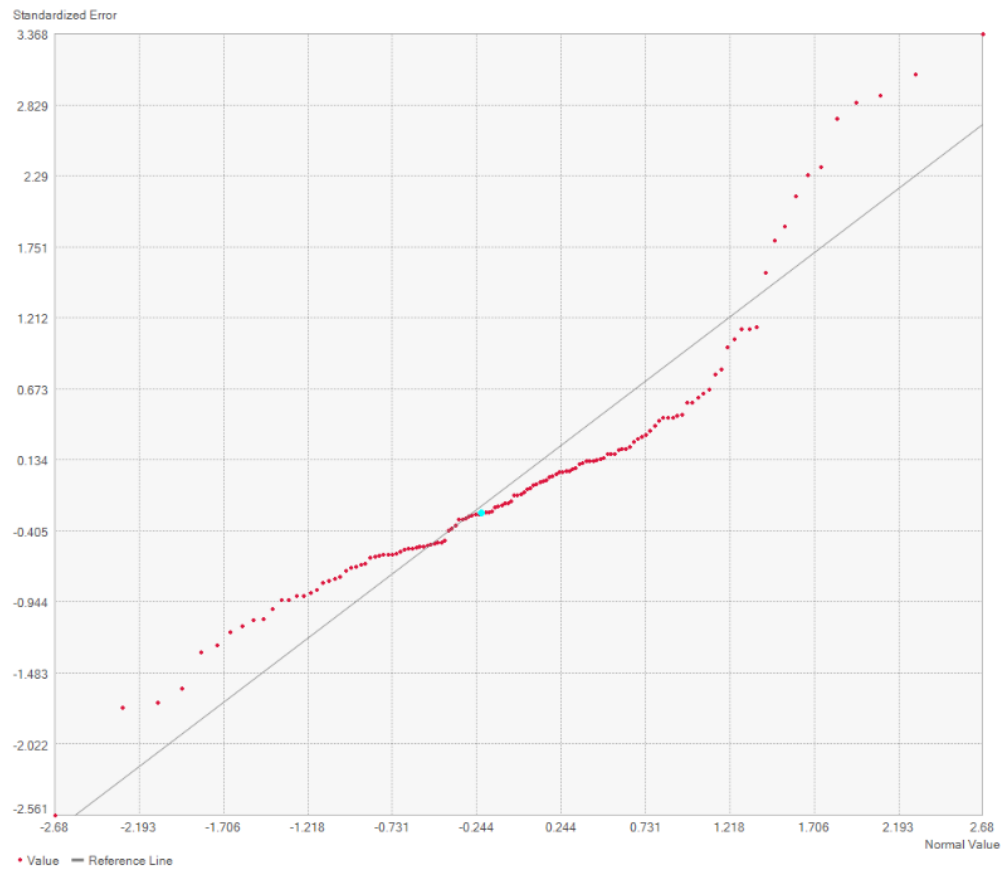

Figure S8D. Standardized-error Q-Q plot;

Supplementary Tables S1-S11.

Supplementary Table S1.

District coverage, national summaries, and distributional statistics for HbS allele frequency datasets

A. Table 1. Dataset coverage

Source	Districts (n)	Individuals (n)
Kiyaga (genotype counts; near-uniform denominators~100)	122	12,009
Ndeezi (percent trait/disease; variable denominators)	112	97,631
Combined (harmonized and summed by district)	128	109,640

B. National genotype/allele summaries (person-weighted from aggregated counts)

Source	HbAS (%)	HbSS (%)	S-allele frequency (q)	Total alleles (2N)	S alleles (2·SS + AS)
Kiyaga	11.03	0.53	0.0605	—	—
Ndeezi	13.29	0.74	0.0738	—	—
Combined	13.04	0.72	0.07237	219,280	15,870

C. District-level distribution of S-allele frequency (q)

Source	Median (q)	IQR	Minimum	Maximum
Kiyaga	0.061	0.055	0.000	0.152
Combined	**0.07454**	**0.05169**	**0.005**	**0.13960**

Notes. Values in panel B for Kiyaga and Ndeezi are computed from their respective aggregated district counts; the **Combined** row is recomputed from summed district genotypes (not averages of source-specific frequencies). In the combined file, (q=15,870/219,280=0.07237). Under Hardy-Weinberg equilibrium, (2pq\approx 13%) and (q^2\approx 0.5%) when (q\approx 0.07); observed national HbAS (13.04%) closely tracks (2pq), while HbSS (0.72%) is modestly above (q^2), consistent with rounding and small-area departures.

Supplementary Table S2.

Table 2. National mean, interquartile range, and area share above 0.01, 0.05, and 0.10 thresholds.

Metric	Value
HbS_median	0.064609
HbS_IQR_Q1	0.04825
HbS_IQR_Q3	0.084607
HbS_pct_pixels_ge_5pct	72.22989
HbS_pct_pixels_ge_10pct	1.626577
PfPR_area_weighted_mean	0.26049
PfPR_pct_land_ge_0.30	94.37193
CoRisk_p95	0.040742
Pct_land_CoRisk_ge_0.20	93.64605

Supplementary Table S3.

Table 3. Endemicity bands (Cell counts and percent of national area in hypoendemic, mesoendemic, hyperendemic, and holoendemic classes based on the decade mean).

Class	Area (km²)	Share (%)
Hypo < 0.10	9,827.5	4.5
Meso 0.10–<0.50	194,226.9	88
Hyper 0.50–<0.75	4,121.3	1.9
Holo ≥ 0.75	0	0

Supplementary Table S4.

Table 4. Co-risk quantiles and exceedance areas. Empirical deciles of the national co-risk distribution and percent of national land with HbS×PfPR ≥ 0.02 and ≥ 0.05.

Threshold	Share (%)
0.02	93.6
0.05	93.6
0.1	93.6
0.2	93.6

Supplementary Table S5.

Table 5. Unserved baseline after existing coverage (National sums and percent reduction after masking existing coverage.)

Metric	Total co-risk	Unserved co-risk	Absolute reduction	Percent reduction
Simple sum	190.6418	113.6674	76.97445	40.37647
Area weighted_km2	4070.841	2427.163	1643.679	40.37688

Supplementary Table S6.

Table 6. Greedy placement of 50 sites at 25 km (Rank, easting and northing in meters (EPSG:32636), longitude and latitude (WGS84), co-risk captured at pick, cumulative captured, and percent of baseline captured).

Rank	Longitude	Latitude	Co-risk at pick	Co-risk captured cum	% of baseline
1	32.88188	2.41665	0.050653	0.050653	0.044563
2	32.59103	2.333002	0.047282	0.097935	0.08616
3	32.17546	2.458197	0.046777	0.144712	0.127312
4	32.5909	2.750961	0.046756	0.191469	0.168446
5	33.08967	2.625638	0.045074	0.236543	0.208101
6	32.84029	2.709224	0.044753	0.281296	0.247473
7	32.1756	2.20744	0.044385	0.325681	0.286521
8	33.87839	0.243153	0.044106	0.369787	0.325324
9	32.42474	2.541918	0.043299	0.413086	0.363417
10	33.17285	3.001799	0.042989	0.456076	0.401237

11	33.33906	2.709187	0.042828	0.498903	0.438915
12	32.84026	2.960004	0.041158	0.540061	0.475124
13	32.8819	2.165868	0.040743	0.580805	0.510969
14	33.29725	1.371702	0.040337	0.621141	0.546455
15	31.76018	2.20715	0.040172	0.661314	0.581797
16	33.13121	2.374852	0.039742	0.701056	0.616761
17	33.71327	2.959785	0.039381	0.740438	0.651407
18	33.46366	2.458372	0.039236	0.779674	0.685926
19	32.38299	2.918049	0.038676	0.81835	0.719951
20	32.21685	2.70898	0.037521	0.855871	0.752961
21	33.04807	1.413518	0.03738	0.893252	0.785847
22	33.50475	0.15958	0.03683	0.930081	0.818248
23	33.71294	2.374674	0.036538	0.96662	0.850393
24	31.17861	2.2901	0.036219	1.002838	0.882257
25	33.50511	2.165788	0.036146	1.038984	0.914057
26	31.67687	2.457794	0.035528	1.074512	0.945313
27	33.29764	3.252548	0.035418	1.10993	0.976472
28	33.54637	1.120884	0.034539	1.144469	1.006858
29	32.59077	3.085327	0.034208	1.178676	1.036952
30	33.96215	2.249148	0.034002	1.212678	1.066865
31	33.58811	1.914987	0.033893	1.246571	1.096683
32	33.92092	2.708883	0.033601	1.280171	1.126243

33	33.21453	3.503346	0.03319	1.313362	1.155443
34	33.58802	1.62242	0.033131	1.346492	1.18459
35	33.83736	1.956676	0.032963	1.379456	1.21359
36	31.71817	2.708553	0.032573	1.412029	1.242246
37	32.29969	3.168761	0.032535	1.444564	1.270869
38	31.96728	2.959532	0.032434	1.476998	1.299403
39	32.63272	1.706066	0.032102	1.509099	1.327645
40	33.54717	3.294238	0.031733	1.540832	1.355562
41	33.25582	2.124054	0.031724	1.572556	1.383471
42	32.71582	1.455298	0.031509	1.604065	1.411192
43	32.71539	3.503327	0.031158	1.635223	1.438603
44	34.0865	1.831163	0.03115	1.666373	1.466008
45	31.59436	1.830939	0.031136	1.697508	1.493399
46	33.50481	0.870115	0.031065	1.728573	1.520729
47	32.88197	1.037338	0.030908	1.75948	1.54792
48	32.34195	1.789578	0.030373	1.789854	1.574641
49	33.96269	2.959596	0.030333	1.820187	1.601327
50	32.84038	1.915081	0.03028	1.850467	1.627966

Supplementary Table S7.

Table 7. Proposed matched sites to existing health facilities

Proposed rank	Proposed lon	Proposed lat	Facility name	Type	Ownership	Authority	Status	Facility lon	Facility lat
1	32.88188	2.41665	Ogur HC IV	HC IV	Government	MOH	Functional	32.93588	2.44195
2	32.59103	2.333002	Agulurude HC III	HC III	Government	MOH	Functional	32.6103	2.2945
5	33.08967	2.625638	Okwang HC III	HC III	Government	MOH	Functional	33.14869	2.6032
6	32.84029	2.709224	Awere HC III	HC III	Government	MOH	Functional	32.79421	2.68842
7	32.1756	2.20744	Diima HC III	HC III	Government	MOH	Functional	32.22003	2.16412
8	33.87839	0.243153	Buyinja HC IV	HC IV	Government	MOH	Functional	33.87629	0.3358
9	32.42474	2.541918	Opit HC III	HC III	Government	UCMB	Functional	32.47537	2.61763
11	33.33906	2.709187	Patongo HC III	HC IV	Government	MOH	Functional	33.30378	2.778143
13	32.8819	2.165868	Ober HC III	HC III	Government	MOH	Functional	32.87364	2.25697
16	33.13121	2.374852	Apala HC III	HC III	Government	MOH	Functional	33.04103	2.40401
17	33.71327	2.959785	Alerek HC III	HC III	Government	MOH	Functional	33.73088	2.95626
18	33.46366	2.458372	Olilim HC III	HC III	Government	MOH	Functional	33.50511	2.4486
19	32.38299	2.918049	Awach HC IV	HC IV	Government	MOH	Functional	32.40077	2.97058
20	32.21685	2.70898	Ongako HC III	HC III	Government	MOH	Functional	32.22965	2.67768
24	31.17861	2.2901	Parombo HC III	HC III	Government	MOH	Functional	31.19591	2.30068

25	33.50511	2.165788	Morungatuny HC III	HC III	Government	MOH	Functional	33.47681	2.17372
27	33.29764	3.252548	Omiya Anyima HC III	HC III	Government	MOH	Functional	33.20667	3.27004
28	33.54637	1.120884	Namwiwa HC III	HC III	Government	MOH	Functional	33.55064	1.08656
31	33.58811	1.914987	Tubur HC III	HC III	Government	MOH	Functional	33.51942	1.95525
34	33.58802	1.62242	Asuret HC III	HC III	Government	MOH	Functional	33.59892	1.628748
35	33.83736	1.956676	Abarilela HC III	HC III	Government	MOH	Functional	33.81817	1.962
41	33.25582	2.124054	Alanyi HC III	HC III	Private Not For Profit	UCMB	Functional	33.26303	2.13244
43	32.71539	3.503327	Padibe West HC III	HC III	Government	MOH	Functional	32.81643	3.4872
46	33.50481	0.870115	Namugongo HC III	HC III	Government	MOH	Functional	33.48277	0.89568
47	32.88197	1.037338	Bbaale HC IV	HC IV	Government	MOH	Functional	32.88569	1.1056
48	32.34195	1.789578	Akokoro HC III	HC III	Government	MOH	Functional	32.39149	1.69949
49	33.96269	2.959596	Lokitelaebu HC III	HC III	Government	MOH	Functional	34.00117	2.98911
50	32.84038	1.915081	Abedober HC III	HC III	Private Not For Profit	UCMB	Functional	32.8508	1.94593

Supplementary Table S8.

Table 8. Coverage curve and marginal returns (Percent of baseline co-risk captured at 10, 20, 30, 40, and 50 sites).

Sites	Percent captured
10	19.65101
20	33.57185
30	45.17405
40	57.51306
50	65.5775

Supplementary Table S9.

Table 9. Equity and spatial concentration of benefits (Captured co-risk by district, district rank, and share of district baseline captured after 50 sites).

Rank	District	Captured	Share of total
1	Pader	5.242049	7.03251
2	Oyam	3.812487	5.11467
3	Lamwo	3.697246	4.960068
4	Kitgum	3.602888	4.833481
5	Nwoya	3.558846	4.774396
6	Amuru	3.477403	4.665135

7	Kotido	3.354674	4.500488
8	Gulu	3.143004	4.216521
9	Omoro	2.990208	4.011536
10	Kiryandongo	2.838674	3.808244
11	Otuke	2.544894	3.414121
12	Alebtong	2.442642	3.276945
13	Katakwi	2.409669	3.232709
14	Lira	2.406753	3.228797
15	Agago	2.305701	3.09323
16	Kole	2.02612	2.718156
17	Buyende	1.97818	2.653841
18	Serere	1.886197	2.530441
19	Masindi	1.882711	2.525765
20	Amuria	1.862115	2.498134
21	Kapelebyong	1.855297	2.488988
22	Napak	1.637628	2.196972
23	Soroti	1.53615	2.060834
24	Amolatar	1.483244	1.989857
25	Abim	1.248141	1.674453
26	Kayunga	1.038341	1.392994
27	Kwania	0.897218	1.203669
28	Kaliro	0.815275	1.093738

29	Nakasongola	0.69625	0.934059
30	Namayingo	0.674003	0.904213
31	Adjumani	0.581003	0.779448
32	Apac	0.481229	0.645596
33	Buliisa	0.475962	0.63853
34	Dokolo	0.462699	0.620737
35	Namutumba	0.454736	0.610055
36	Nebbi	0.368423	0.494261
37	Buvuma	0.352111	0.472378
38	Pakwach	0.315842	0.42372
39	Luwero	0.302074	0.40525
40	Pallisa	0.28177	0.378011
41	Nabilatuk	0.280291	0.376027
42	Kaberamaido	0.222661	0.298712
43	Mayuge	0.162582	0.218113
44	Kibuku	0.140797	0.188888
45	Karenga	0.096298	0.12919
46	Kamuli	0.089006	0.119407
47	Ngora	0.056584	0.075911
48	Busia	0.041093	0.055129
49	Iganga	0.031065	0.041675
50	Amudat	0	0

51	Arua	0	0
52	Budaka	0	0
53	Bududa	0	0
54	Bugiri	0	0
55	Bugweri	0	0
56	Buhweju	0	0
57	Buikwe	0	0
58	Bukedea	0	0
59	Bukomansimbi	0	0
60	Bukwo	0	0
61	Bulambuli	0	0
62	Bundibugyo	0	0
63	Bunyangabu	0	0
64	Bushenyi	0	0
65	Butaleja	0	0
66	Butambala	0	0
67	Butebo	0	0
68	Gomba	0	0
69	Hoima	0	0
70	Ibanda	0	0
71	Isingiro	0	0
72	Jinja	0	0

73	Kaabong	0	0
74	Kabale	0	0
75	Kabarole	0	0
76	Kagadi	0	0
77	Kakumiro	0	0
78	Kalaki	0	0
79	Kalangala	0	0
80	Kalungu	0	0
81	Kampala	0	0
82	Kamwenge	0	0
83	Kanungu	0	0
84	Kapchorwa	0	0
85	Kasese	0	0
86	Kassanda	0	0
87	Kazo	0	0
88	Kibaale	0	0
89	Kiboga	0	0
90	Kikuube	0	0
91	Kiruhura	0	0
92	Kisoro	0	0
93	Kitagwenda	0	0
94	Koboko	0	0

95	Kumi	0	0
96	Kween	0	0
97	Kyankwanzi	0	0
98	Kyegegwa	0	0
99	Kyenjojo	0	0
100	Kyotera	0	0
101	Luuka	0	0
102	Lwengo	0	0
103	Lyantonde	0	0
104	Madi Okollo	0	0
105	Manafwa	0	0
106	Maracha	0	0
107	Masaka	0	0
108	Mbale	0	0
109	Mbarara	0	0
110	Mitooma	0	0
111	Mityana	0	0
112	Moroto	0	0
113	Moyo	0	0
114	Mpigi	0	0
115	Mubende	0	0
116	Mukono	0	0

117	Nakapiripirit	0	0
118	Nakaseke	0	0
119	Namisindwa	0	0
120	Ntoroko	0	0
121	Ntungamo	0	0
122	Obongi	0	0
123	Rakai	0	0
124	Rubanda	0	0
125	Rubirizi	0	0
126	Rukiga	0	0
127	Rukungiri	0	0
128	Rwampara	0	0
129	Sheema	0	0
130	Sironko	0	0
131	Ssembabule	0	0
132	Tororo	0	0
133	Wakiso	0	0
134	Yumbe	0	0
135	Zombo	0	0

Supplementary Table S10.

Table 10. Radius sensitivity milestones (Minimum number of sites needed to reach 60, 70, and 80 percent capture for each radius).

Radius km	Number of sites for 60% cappture	Number of sites for 70% cappture	Number of sites for 80% cappture
20	23	32	40
25	18	25	31
30	16	19	26
40	10	12	14
50	5	9	12

Supplementary Table S11.

Table 11. EBK cross-validation statistics.

Metric	**Value**
Count	136
Average CRPS	0.015820
Inside 90 Percent Interval (%)	90.4

Inside 95 Percent Interval (%)	93.4
Mean Error	0.000005
Root-Mean-Square Error (RMSE)	0.029916
Mean Standardized Error	0.000582
Root-Mean-Square Standardized Error (RMSSE)	0.948309
Average Standard Error (ASE)	0.031099