5.3 Supplementary Figures and Tables

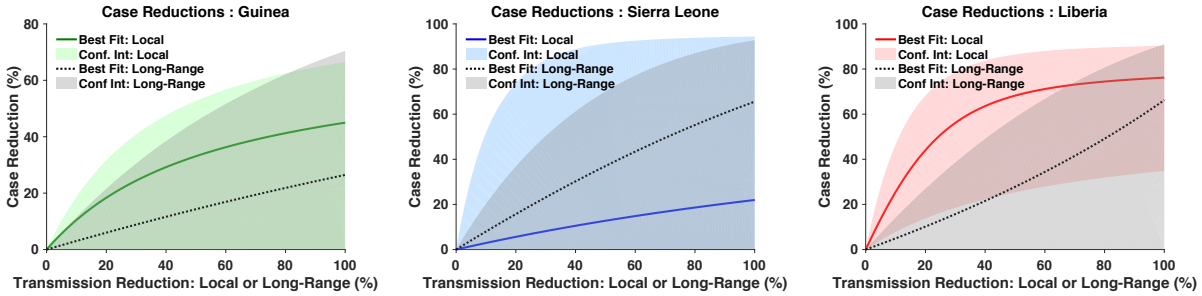

Figure A1: Cases reduced by various interventions at the country-level. Transmission reduction represents reduction of local or long-range transmission in increments of one percent. Case reduction is measured by comparing total cases in all 3 countries in the presence of intervention to total cases in the absence of intervention, on October 31, 2014.

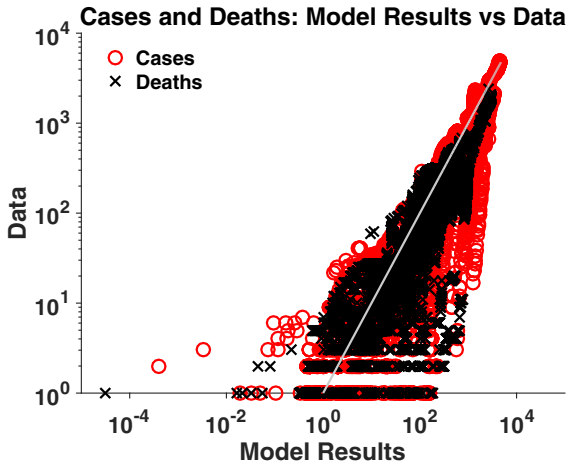

Figure A2: Comparison of all data points for cumulative cases and deaths in each of the 63 patches: comparison of deterministic model values (x axis) and data (y axis). R^2 value of 0.8321.

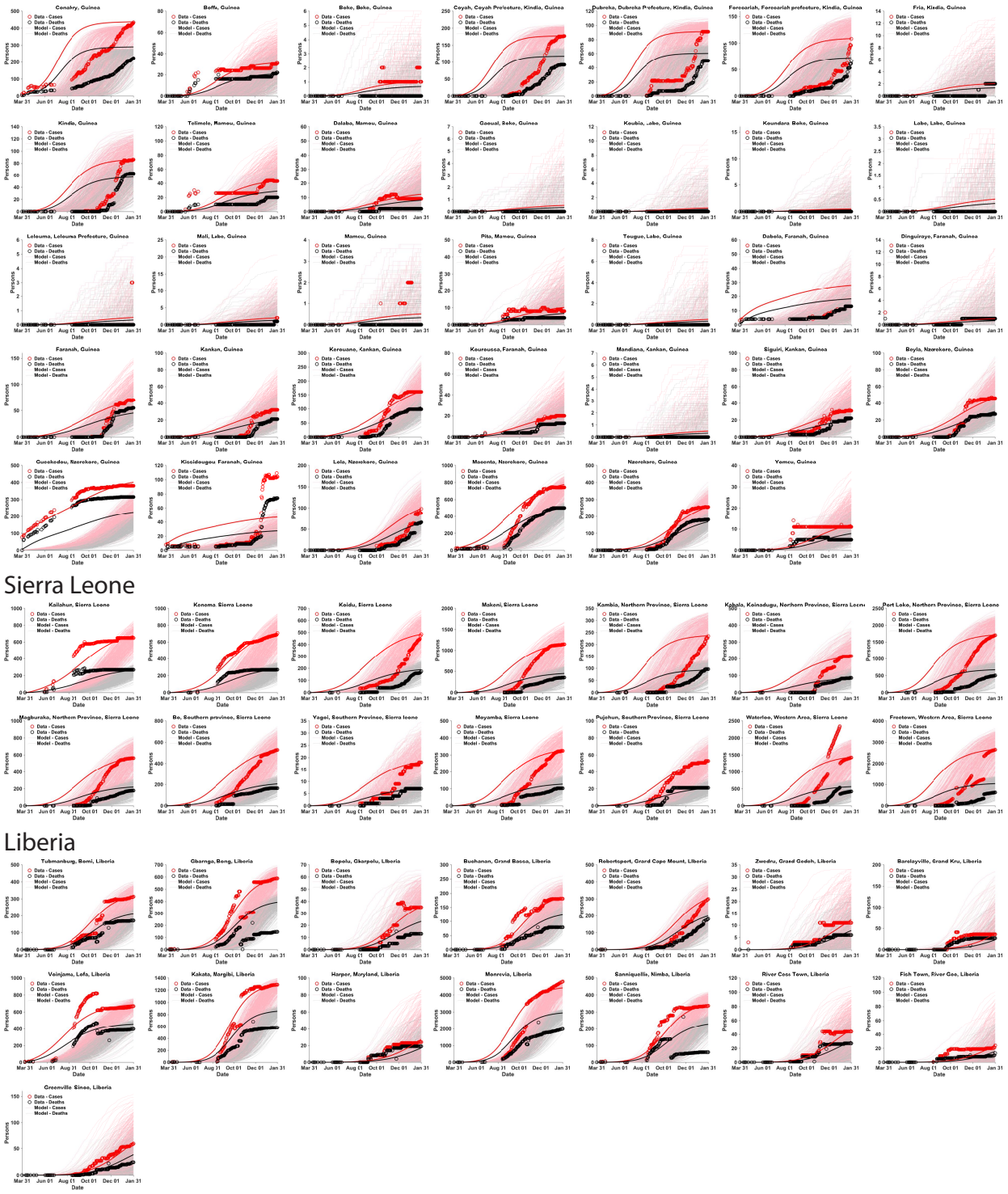

Figure A3: Cumulative cases and deaths for each district. Red and black circles represent data for cases and deaths, respectively. Thick red and black lines represent cumulative cases and deaths (respectively) in the deterministic model; thin pink and grey lines represent cases and deaths (respectively) trajectories sampled from the stochastic model with a reporting rate of 5 actual cases to each reported case for each patch ($r = 1/5$), with the population at risk equal to $5k_{norm}\rho_n$). For the other reporting rates tested, see the Supplementary File containing Figures S1-S8. Model projections are from March 30, 2014 to January 31, 2015.

Table A1: Parameter values and estimates for the country-level model.

Parameter	Definition	Units	Best Fit	Range	Sources
α	Transition rate from E to I_1	days^{-1}	0.1059	0.1-0.125	[5, 58]
β_{1G}	Transmission rate for I_1 in Guinea	$\text{persons}^{-1}\ \text{days}^{-1}$	0.0950	Initial: 0-0.5, Fitted: 0.0000 to 0.0676	fitted to data [1]
β_{1SL}	Transmission rate for I_1 in Sierra Leone	$\text{persons}^{-1}\ \text{days}^{-1}$	0.0504	Initial: 0-0.5, Fitted: 0.0005 to 0.1858	fitted to data [1]
β_{1L}	Transmission rate for I_1 in Liberia	$\text{persons}^{-1}\ \text{days}^{-1}$	0.1555	Initial: 0-0.5, Fitted: 0.0727 to 0.1656	fitted to data [1]
β_R	Ratio of I_1 transmission to I_2 and F transmission	none	2.4565	1.5-3.0	[5, 15]
β_{2G}, β_{FG}	Transmission rate for I_2 and F in Guinea	$\text{persons}^{-1}\ \text{days}^{-1}$	0.2335	Calculated from β_1 and β_R	See β_1, β_R
β_{2SL}, β_{FSL}	Transmission rate for I_2 and F in Sierra Leone	$\text{persons}^{-1}\ \text{days}^{-1}$	0.1238	Calculated from β_1 and β_R	See β_1, β_R
$\beta_2 L, \beta_{FL}$	Transmission rate for I_2 and F in Liberia	$\text{persons}^{-1}\ \text{days}^{-1}$	0.3820	Calculated from β_1 and β_R	See β_1, β_R
Δ_G	Mortality for infected persons in Guinea	none	0.6643	Initial: 0.5-0.9, Fitted: 0.3601 to 1.4023	fitted to data [1]
Δ_{SL}	Mortality for infected persons in Sierra Leone	none	0.3910	Initial: 0.5-0.9, Fitted: 0.2547 to 0.6159	fitted to data [1]
Δ_L	Mortality for infected persons in Liberia	none	0.6710	Initial: 0.5-0.9, Fitted: 0.5453 to 0.8236	fitted to data [1]
Δ_2	Fraction of persons in I_2 that dies	none	0.9732	0.9-1.0	[5, 7]
δ	Death rate for persons in I_2	days^{-1}	0.7597	Calculated from Δ_2 and k_{02}	see Δ_2 and k_{02}
δ_2	Burial rate	days^{-1}	0.7425	0.3333-1.0	[31]
k_{02}	1/duration of I_2	days^{-1}	0.7806	0.3-0.8	[5, 34]
k_{21}	1/duration of I_1	days^{-1}	0.1822	0.1429 -0.2	[2, 34]
ι	Distance exponent	unitless	2		fixed
κ_1	Between-patch coupling strength for Guinea	$\text{km}^{\iota}\ \text{persons}^{-2}$	$10^{-10.17}$	Initial: 10^{-8}-10^{-12},Fitted: $10^{-6.21}$ - $10^{-12.54}$	fitted to data [1]
κ_2	Between-patch coupling strength for Sierra Leone	$\text{km}^{\iota}\ \text{persons}^{-2}$	$10^{-8.27}$	Initial: 10^{-8}-10^{-12},Fitted: $10^{-6.13}$-$10^{-21.80}$	fitted to data [1]
κ_3	Between-patch coupling strength for Liberia	$\text{km}^{\iota}\ \text{persons}^{-2}$	$10^{-8.62}$	Initial:10^{-8}-10^{-12},Fitted: $10^{-7.89}$-$10^{-12.10}$	fitted to data [1]
r_{1G}	Recovery rate of persons in I_1 in Guinea	days^{-1}	0.0578	Calculated from Δ_G, Δ_2, k_{21}	fitted to data [1] (See Δ_G, Δ_2, k_{21})
r_{1SL}	Recovery rate of persons in I_1 in Sierra Leone	days^{-1}	0.1090	Calculated from Δ_{SL}, Δ_2, k_{21}	fitted to data [1] (See Δ_{SL}, Δ_2, k_{21})
r_{1L}	Recovery rate of persons in I_1 in Liberia	days^{-1}	0.0566	Calculated from Δ_L, Δ_2, k_{21}	fitted to data [1](See Δ_L, Δ_2, k_{21})
r_2	Recovery rate of persons in I_2	days^{-1}	0.0209	Calculated from Δ_2, k_{02}	[5, 7]
γ_G	Rate and proportion of movement of persons from I_1 to I_2 in Guinea	days^{-1}	0.1243	Calculated from Δ_G, Δ_2, k_{21}	fitted to data [1] (See Δ_G, Δ_2, k_{21})
γ_{SL}	Rate and proportion of movement of persons from I_1 to I_2 in Sierra Leone	days^{-1}	0.0732	Calculated from Δ_{SL}, Δ_2, k_{21}	fitted to data [1](See Δ_{SL}, Δ_2, k_{21})
γ_L	Rate and proportion of movement of persons from I_1 to I_1 in Liberia	days^{-1}	0.1256	Calculated from Δ_L, Δ_2, k_{21}	fitted to data [1](See Δ_L, Δ_2, k_{21})
ρ_n	Population in patch n	persons	–	Fixed for each country	[54]
$d_{n,m}$	distance between patch n and m	km	–	fixed for each combination of patches	[37]
k_{norm}	Correction factor for reporting rate, population at risk, and other factors	unitless	0.0030	0.001-0.1	Sampled

Table A2: Parameter values for the district-level model.

Parameter	Definition	Units	Value	Sources
α	Transition rate from E to I_1	days^{-1}	0.1059	[5, 58]
β_{1G}	Transmission rate for I_1 in Guinea	persons^{-1} days^{-1}	0.0950	fitted to data [1]
β_{1SL}	Transmission rate for I_1 in Sierra Leone	persons^{-1} days^{-1}	0.0504	fitted to data [1]
β_{1L}	Transmission rate for I_1 in Liberia	persons^{-1} days^{-1}	0.1555	fitted to data [1]
β_R	Ratio of I_1 transmission to I_2 and F transmission	none	2	[5, 15]
Δ_G	Mortality for infected persons in Guinea	none	0.6643	fitted to data [1]
Δ_{SL}	Mortality for infected persons in Sierra Leone	none	0.3910	fitted to data [1]
Δ_L	Mortality for infected persons in Liberia	none	0.6710	fitted to data [1]
Δ_2	Fraction of persons in I_2 that dies	none	0.97	[5, 7]
δ_2	Burial rate	days^{-1}	0.9	[31]
k_{02}	1/duration of I_2	days^{-1}	0.8	[5, 34]
k_{21}	1/duration of I_1	days^{-1}	0.2	[2, 34]
γ_G	Rate and proportion of movement of persons from I_1 to I_2 in Guinea	days^{-1}	0.1370	fitted to data [1] (See Δ_G, Δ_2, k_{21})
γ_{SL}	Rate and proportion of movement of persons from I_1 to I_2 in Sierra Leone	days^{-1}	0.0806	fitted to data [1](See Δ_{SL}, Δ_2, k_{21})
γ_L	Rate and proportion of movement of persons from I_1 to I_1 in Liberia	days^{-1}	0.1384	fitted to data [1](See Δ_L, Δ_2, k_{21})
ι	Distance exponent	unitless	2	fixed
κ	Between-patch coupling strength	km$^{\iota}$ persons^{-2}	$10^{-8.5}$	fitted to data [1]
ρ_n	Population in patch n	persons	Fixed for each district	[54]
$d_{n,m}$	distance between patch n and m	km	fixed for each combination of patches	[37]
k_{norm}	Correction factor for reporting rate, population at risk, and other factors	unitless	Varies by patch	Fitted to data (see Table A3)

District	k_{norm}	Population size	District	k_{norm}	Population size
Conakry, Guinea	0.0003366	1667864	Macenta, Nzerekore, Guinea	0.0101	298282
Boffa, Guinea	0.000923	211063	Nzerekore, Guinea	0.003181	396118
Boke, Boke, Guinea	0.0000178	449405	Yomou, Guinea	0.0006865	176664
Coyah, Coyah Prefecture, Kindia, Guinea	0.0010564	264164	Kailahun, Sierra Leone	0.0522204	358190
Dubreka, Dubreka Prefecture, Kindia, Guinea	0.0004088	328418	Kenema, Sierra Leone	0.0367377	497948
Forecariah, Forecariah prefecture, Kindia, Guinea	0.0012858	244649	Koidu, Sierra Leone	0.0693104	335401
Fria, Kindia, Guinea	0.000251	96527	Makeni, Sierra Leone	0.0574733	408390
Kindia, Guinea	0.0006273	438315	Kambia, Northern Province, Sierra Leone	0.010676	270462
Telimele, Mamou, Guinea	0.0012841	283639	Kabala, Koinadugu, Northern Province, Sierra Leone	0.0510831	265758
Dalaba, Mamou, Guinea	0.0012756	136320	Port Loko, Northern Province, Sierra Leone	0.0496909	453746
Gaoual, Boke, Guinea	0.0000592	194245	Magburaka, Northern Province, Sierra Leone	0.0379865	347197
Koubia, Labe, Guinea	0.0001577	101171	Bo, Southern province, Sierra Leone	0.0312373	463668
Koundara, Boke, Guinea	0.0002082	130205	Yagoi, Southern Province, Sierra leone	0.0178945	139687
Labe, Labe, Guinea	0.0000129	318633	Moyamba, Sierra Leone	0.0571064	260910
Lelouma, Lelouma Prefecture, Guinea	0.000053	162634	Pujehun, Southern Province, Sierra Leone	0.0139538	228392
Mali, Labe, Guinea	0.0001403	290320	Waterloo, Western Area, Sierra Leone	0.2759915	174249
Mamou, Guinea	0.0000155	318738	Freetown, Western Area, Sierra Leone	0.0495051	772873
Pita, Mamou, Guinea	0.0002863	277059	Tubmanburg, Bomi, Liberia	0.0079824	84119
Tougue, Labe, Guinea	0.0001236	122959	Gbarnga, Bong, Liberia	0.0032862	333481
Dabola, Faranah, Guinea	0.00135	182951	Bopolu, Gbarpolu, LIberia	0.0010959	83388
Dinguiraye, Faranah, Guinea	0.0001318	195662	Buchanan, Grand Bassa, Liberia	0.0017298	221693
Faranah, Guinea	0.0033718	280511	Robertsport, Grand Cape Mount, Liberia	0.0057712	127076
Kankan, Guinea	0.0007378	472112	Zwedru, Grand Gedeh, Liberia	0.0003692	125258
Kerouane, Kankan, Guinea	0.0125112	211017	Barclayville, Grand Kru, Liberia	0.0058913	57913
Kouroussa, Faranah, Guinea	0.0013535	268224	Voinjama, Lofa, Liberia	0.0044	276863
Mandiana, Kankan, Guinea	0.0000289	339527	Kakata, Margibi, Liberia	0.0101327	209923
Siguiri, Kankan, Guinea	0.0005356	695449	Harper, Maryland, Liberia	0.0010889	135938
Beyla, Nzerekore, Guinea	0.0014797	325482	Monrovia, Liberia	0.0058101	1118241
Gueckedou, Nzerekore, Guinea	0.006499	291823	Sanniquellie, Nimba, Liberia	0.0013842	462026
Kissidougou, Faranah, Guinea	0.0008	283609	River Cess Town, Liberia	0.0022723	71509
Lola, Nzerekore, Guinea	0.0033775	175213	Fish Town, River Gee, Liberia	0.0025472	66789
			Greenville, Sinoe, Liberia	0.0023976	102391

Table A3: District total population sizes (ρ_n) [54] and k_{norm} values used for the deterministic district-level model.

Additional Supplementary Files:

Video S1. A GIF representing the progression of Ebola according to the model from March 30, 2014, to January 31, 2015. Color intensity of district represents number of cumulative cases in that district: darker color represents higher number of cases.

Supplementary Figures S1-S8. Stochastic district-level model simulation figures using reporting rate values $r = 1, \frac{1}{2}, \frac{1}{5}, \frac{1}{10}, 3k_{norm}, 2k_{norm}, 1.5k_{norm}, k_{norm}$ (corresponding to population-at-risk sizes of $f\rho_n = k_{norm}\rho_n, 2k_{norm}\rho_n, 5k_{norm}\rho_n, 10k_{norm}\rho_n, \frac{1}{3}\rho_n, \frac{1}{2}\rho_n, \frac{2}{3}\rho_n$, and ρ_n).