Supplementary Appendices

Supplementary Information for
Spatial Modeling for Subnational Administrative Level 2 Small-Area Estimation

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APPENDIX A RESULTS OF ADMIN 2 ESTIMATES

Table A.1 Summarized U5MR Admin 1 estimates (per 1,000 live births) and 95% uncertainty interval for Zambia DHS 2018

Admin 1 Name	Median	Mean	Lower	Upper
Central	43.5	44.2	32.7	58.8
Western	53.0	53.7	39.0	71.0
Copperbelt	45.3	46.1	32.4	65.7
Eastern	54.8	55.2	41.7	70.3
Luapula	84.1	84.6	62.9	107.0
Lusaka	52.3	53.2	38.0	72.4
Muchinga	61.6	62.2	46.7	81.2
North-Western	30.5	30.9	20.9	43.9
Northern	56.0	56.5	40.9	72.7
Southern	44.1	44.8	32.6	59.5

Table A.2 Summarized U5MR Admin 2 estimates (per 1,000 live births) and 95% uncertainty interval for Zambia DHS 2018

Admin 2 Name	Median	Mean	Lower	Upper
Chibombo	33.5	34.5	20.4	53.0
Kitwe	40.7	41.9	22.4	69.1
Luanshya	36.4	38.6	18.6	72.5
Lufwanyama	51.0	54.5	26.4	100.8
Masaiti	40.0	41.3	22.2	69.5
MPongwe	32.4	33.6	15.5	60.4
Mufulira	47.2	50.2	22.9	96.0
Ndola	40.5	43.2	21.6	76.7
Chadiza	46.6	49.6	21.2	92.6
Chipata	61.1	62.5	40.8	90.3
Katete	40.4	41.6	23.3	66.5
Kabwe	29.1	31.5	14.7	59.1
Lundazi	78.3	78.7	49.6	112.3
Mambwe	47.5	49.9	24.4	91.2
Nyimba	35.0	36.1	19.8	59.3
Petauke	35.1	36.6	18.9	63.4
Chiengi	124.0	125.5	76.6	181.4
Kawambwa	48.4	50.1	27.9	79.4
Mansa	59.7	61.1	37.3	89.2
Milenge	39.3	42.7	16.7	91.0
Mwense	56.5	59.0	33.3	97.5
Nchelenge	110.1	112.5	69.8	163.8
Kapiri Mposhi	47.1	49.3	29.3	79.2
Samfya	75.9	77.2	49.0	113.1
Chongwe	29.0	30.3	15.4	52.1
Kafue	43.9	45.5	27.1	70.2
Luangwa	28.4	30.4	11.6	61.4
Lusaka	63.3	64.4	42.9	94.2
Chama	47.3	48.6	27.8	76.9
Chinsali	47.9	49.0	30.0	75.5
Isoka	90.7	92.1	58.2	136.5
Mpika	43.7	44.5	27.5	66.3
Nakonde	65.6	67.4	38.8	103.9
Mkushi	42.3	44.2	23.9	73.5
Chavuma	45.5	50.2	18.8	111.7
Kabompo	26.1	27.8	12.1	52.5
Kasempa	34.1	36.0	19.1	67.8
Mufumbwe	28.8	30.1	13.7	55.6
Mwinilunga	20.4	22.1	10.0	43.5
Solwezi	35.5	36.6	21.5	60.3
Zambezi	24.8	26.8	11.8	53.2
Chilubi	35.9	37.3	18.7	65.3
Kaputa	104.6	106.7	62.2	163.3
Kasama	40.6	42.1	24.6	67.1
Mumbwa	26.9	28.2	14.7	47.5
Luwingu	30.9	32.4	15.7	56.7
Mbala	58.7	60.5	34.4	98.7
Mporokoso	59.0	61.4	35.5	99.3
Mpulungu	82.2	83.2	48.3	126.2
Mungwi	32.5	34.2	17.0	60.5
Choma	65.1	66.3	39.9	101.4
Gwembe	37.4	40.8	15.6	85.2
Itezhi-Tezhi	25.5	27.5	12.1	52.0
Kalomo	49.9	51.3	29.2	81.6
Kazungula	55.6	57.8	29.0	104.5
Serenje	63.2	65.0	38.0	104.5
Livingstone	58.0	61.2	30.6	116.2
Mazabuka	26.5	27.6	14.2	47.1
Monze	22.1	23.1	11.1	41.6
Namwala	38.5	41.7	17.2	83.2
Siavonga	42.4	45.1	20.5	86.7
Sinazongwe	45.4	48.4	22.1	91.3
Kalabo	61.3	63.4	35.9	106.5
Kaoma	45.8	47.7	27.8	77.6
Lukulu	35.4	37.5	17.6	68.1
Mongu	56.4	58.5	33.6	92.9
Chililabombwe	56.1	60.0	26.8	119.6
Senanga	56.1	57.5	33.5	92.5
Sesheke	47.2	48.8	24.7	85.0
Shangombo	64.8	67.7	34.5	116.6
Chingola	61.1	65.0	33.7	114.2
Kalulushi	51.9	54.4	26.7	100.2

Table A.3 Summarized U5MR Admin 1 estimates (per 1,000 live births) and 95% uncertainty interval for Bangladesh DHS 2018

Admin 1 Name	Median	Mean	Lower	Upper
Barisal	38.8	39.6	26.3	58.0
Chittagong	35.5	36.3	23.7	54.6
Dhaka	38.7	39.2	27.3	54.4
Khulna	35.6	36.6	23.7	55.8
Rajshahi	39.2	40.4	26.8	61.0
Rangpur	34.9	35.4	21.6	52.2
Sylhet	44.3	45.3	29.0	67.1

Table A.4 Summarized U5MR Admin 2 estimates (per 1,000 live births) and 95% uncertainty interval for Bangladesh DHS 2018

Admin 2 Name	Median	Mean	Lower	Upper
Barguna	35.0	36.1	19.8	60.9
Chittagong	29.7	30.7	16.9	50.4
Comilla	31.2	32.3	17.1	53.5
Cox'S Bazar	38.4	40.2	20.0	69.7
Feni	36.6	38.2	20.7	65.5
Khagrachhari	31.0	33.1	15.6	61.1
Lakshmipur	36.6	38.0	21.0	62.5
Noakhali	41.5	43.1	24.9	70.0
Rangamati	33.8	34.5	16.3	61.5
Dhaka	43.5	45.1	25.4	71.4
Faridpur	34.4	36.3	20.4	60.8
Barisal	37.3	38.8	22.1	60.0
Gazipur	41.1	42.5	23.7	69.7
Gopalganj	34.8	36.2	18.4	60.2
Jamalpur	33.9	34.6	19.4	53.7
Kishoreganj	38.9	40.6	22.9	66.9
Madaripur	32.3	33.7	18.3	57.8
Manikganj	33.9	35.2	18.8	59.6
Munshiganj	34.1	35.0	19.0	57.8
Mymensingh	34.3	35.0	20.7	55.4
Narayanganj	40.5	42.1	23.4	71.0
Narsingdi	41.5	43.4	25.5	73.2
Bhola	41.6	42.8	24.7	67.9
Netrakona	36.3	37.4	21.6	59.3
Rajbari	34.4	36.1	19.5	63.0
Shariatpur	35.7	37.2	20.5	63.0
Sherpur	35.8	36.9	19.8	63.8
Tangail	33.7	34.9	19.4	56.7
Bagerhat	35.0	36.5	20.1	62.4
Chuadanga	30.6	32.0	15.6	59.3
Jessore	32.9	34.1	18.4	58.5
Jhenaidah	33.2	34.3	18.6	58.6
Khulna	38.3	39.6	22.6	64.8
Jhalokati	33.5	35.2	18.4	62.9
Kushtia	37.6	39.0	22.0	63.6
Magura	32.9	34.1	17.2	58.1
Meherpur	32.1	33.6	15.9	62.1
Narail	32.1	33.3	17.5	55.7
Satkhira	36.4	37.5	19.3	63.3
Bogra	39.8	41.7	25.1	66.7
Joypurhat	38.6	40.4	22.2	69.3
Naogaon	41.9	44.8	26.0	79.5
Natore	32.7	33.6	17.7	55.0
Nawabganj	36.8	38.6	20.2	67.0
Patuakhali	34.2	35.8	19.7	58.7
Pabna	36.7	38.2	21.6	62.1
Rajshahi	34.7	36.3	19.8	60.0
Sirajganj	32.7	34.0	19.8	53.9
Dinajpur	33.5	34.2	19.1	56.3
Gaibandha	37.3	38.5	22.0	62.8
Kurigram	32.5	33.5	18.3	55.5
Lalmonirhat	40.0	41.8	23.6	72.2
Nilphamari	36.0	37.2	20.1	61.6
Panchagarh	36.8	38.2	19.8	63.3
Rangpur	37.2	38.5	20.9	62.9
Pirojpur	36.6	37.5	20.9	60.6
Thakurgaon	31.5	33.0	16.5	56.4
Habiganj	43.4	44.9	26.5	71.9
Maulvibazar	50.8	53.2	29.8	91.9
Sunamganj	40.2	41.4	24.8	66.5
Sylhet	45.0	46.3	28.5	69.4
Bandarban	35.7	37.1	17.3	63.9
Brahamanbaria	35.1	36.4	20.3	58.7
Chandpur	39.0	41.2	22.7	70.2

Table A.5 Summarized U5MR Admin 1 estimates (per 1,000 live births) and 95% uncertainty interval for Cameroon DHS 2018

Admin 1 Name	Median	Mean	Lower	Upper
Adamaoua	86.1	86.6	65.5	113.4
Sud-Ouest	59.3	61.3	36.3	96.7
Centre	74.2	74.5	56.4	94.0
Est	123.5	124.1	94.4	157.2
Extrême-Nord	92.0	93.0	67.5	124.2
Littoral	41.3	42.1	29.4	57.9
Nord	104.7	105.8	80.6	135.6
Nord-Ouest	52.8	53.5	35.7	74.4
Ouest	67.6	68.3	50.6	89.9
Sud	96.2	97.3	73.0	127.1

Table A.6 Summarized U5MR Admin 2 estimates (per 1,000 live births) and 95% uncertainty interval for Cameroon DHS 2018

Admin 2 Name	Median	Mean	Lower	Upper
Djerem	83.6	85.5	56.0	123.7
Mefou et Afamba	73.1	74.7	47.7	110.5
Mefou et Akono	77.3	79.2	47.9	127.4
Mfoundi	66.6	67.4	45.9	94.6
Nyong et Kéllé	87.3	88.2	54.7	133.5
Nyong et Mfoumou	85.1	86.8	55.8	128.7
Nyong et So'o	81.3	83.1	53.1	121.2
Boumba et Ngoko	114.0	116.4	71.5	176.7
Haut Nyong	107.8	109.0	74.9	151.2
Kadey	106.3	109.0	74.9	156.3
Lom et Djerem	130.3	131.6	96.8	176.5
Faro et Déo	98.5	101.1	64.2	154.5
Diamaré	88.4	89.7	60.2	126.4
Logone et Chari	110.5	112.9	70.6	168.6
Mayo Danay	85.5	88.1	55.9	136.8
Mayo Kani	83.4	86.7	52.8	139.6
Mayo Sava	110.3	113.2	71.6	164.2
Mayo Tsanaga	88.6	91.0	60.5	132.9
Moungo	37.6	38.4	24.8	55.9
Nkam	58.6	60.0	35.7	90.5
Sanaga Maritime	59.5	60.7	38.9	88.5
Wouri	43.3	44.5	28.8	65.2
Mayo Banyo	82.5	83.0	57.3	116.5
Bénoué	104.3	105.9	75.7	143.0
Faro	109.3	111.7	72.0	164.2
Mayo Louti	113.2	114.6	76.6	163.6
Mayo Rey	102.6	104.3	68.3	149.1
Boyo	64.3	67.1	36.7	116.5
Bui	51.7	53.2	30.8	84.9
Donga Mantung	62.3	63.4	40.1	96.0

Admin 2 Name	Median	Mean	Lower	Upper
Menchum	66.1	68.0	37.8	112.4
Mezam	56.1	57.3	34.8	86.7
Momo	62.9	65.6	33.7	113.0
Mbéré	88.0	89.2	57.7	129.2
Ngo Ketunjia	58.5	59.7	35.2	91.9
Bamboutos	57.8	59.0	38.0	86.7
Haut Nkam	63.4	64.7	38.7	96.8
Hauts Plateaux	70.1	72.9	43.3	116.4
Koung Khi	62.5	64.8	36.1	104.4
Menoua	54.8	56.1	36.6	82.0
Mifi	54.8	55.5	34.0	84.7
Ndé	68.7	70.4	43.0	103.9
Noun	84.0	84.5	60.2	115.2
Dja et Lobo	113.6	115.6	81.4	158.8
Vina	89.3	91.0	63.9	130.1
Mvila	77.4	79.1	51.8	113.6
Océan	76.9	78.5	49.3	117.9
Vallée du Ntem	98.3	100.8	63.7	152.4
Fako	51.2	52.9	30.7	80.1
Koupé Manengouba	60.8	62.7	35.3	104.1
Lebialem	56.6	58.4	32.9	93.9
Manyu	62.7	65.2	35.7	105.1
Meme	54.7	55.9	30.9	90.3
Ndian	61.5	63.4	33.1	106.5
Haute Sanaga	91.7	92.9	60.6	131.3
Lekié	83.1	84.0	59.0	118.0
Mbam et Inoubou	89.4	91.8	64.1	131.2
Mbam et Kim	96.3	97.9	65.7	137.8

Table A.7 Summarized U5MR Admin 1 estimates (per 1,000 live births) and 95% uncertainty interval for Ethiopia DHS 2016

Admin 1 Name	Median	Mean	Lower	Upper
Addis Ababa	29.6	30.8	16.8	50.6
Southern Nations, Nationalities and Peoples	67.0	68.1	48.9	91.6
Tigray	50.5	51.4	36.6	70.6
Afar	96.7	97.7	74.2	128.1
Amhara	60.5	60.7	42.6	81.9
Benshangul-Gumaz	70.5	70.8	49.0	96.7
Dire Dawa	53.0	53.7	35.7	77.1
Gambela Peoples	69.3	70.1	50.4	96.6
Harari People	57.4	58.4	39.1	83.1
Oromia	62.9	63.1	46.0	82.1
Somali	75.1	76.3	55.6	103.7

Table A.8 Summarized U5MR Admin 2 estimates (per 1,000 live births) and 95% uncertainty interval for Ethiopia DHS 2016

Admin 2 Name	Median	Mean	Lower	Upper
Addis Ababa	27.8	29.4	16.2	49.2
Debub Gondar	48.0	49.6	28.0	78.2
Debub Wollo	80.9	82.8	44.3	129.5
Mirab Gojjam	44.9	46.3	24.0	73.8
Misraq Gojjam	51.7	53.2	29.2	84.9
North Shewa, Amhara	75.2	78.3	43.9	126.3
Oromia	67.3	70.0	35.4	121.4
Semen Gondar	63.4	64.6	39.7	97.6
Semen Wello	70.1	71.1	38.6	111.4
Wag Himra	59.6	61.8	32.4	104.0
Asosa	72.8	74.0	45.6	107.4
Afar Zone 1	97.7	100.1	65.5	145.3
Kemashi	75.1	77.6	46.4	120.7
Metekel	54.6	56.1	33.9	86.7
Dire Dawa	52.1	53.6	33.3	82.3
Agnuak	61.7	62.9	39.2	92.7
Majang	64.7	66.8	40.5	106.5
Nuer	74.1	78.1	44.0	132.2
Hareri	58.4	60.7	37.2	95.8
Arsi	75.7	77.9	47.9	121.1
Bale	57.7	59.6	33.2	97.1
Borena	79.7	81.3	47.1	127.5
Afar Zone 2	83.0	85.1	53.8	127.6
Debub Mirab Shewa	55.1	57.4	27.5	101.5
Guji	63.2	66.0	38.0	106.1
Horo Guduru	61.3	63.0	31.8	108.3
Ilubabor	63.2	65.1	36.3	103.5
Jimma	63.2	64.8	39.5	98.5
Kelem Wellega	66.7	69.5	34.8	124.3
Mirab Arsi	65.4	67.1	39.9	103.1
Mirab Hararghe	72.3	74.7	43.1	119.5
Mirab Shewa	47.0	48.2	26.1	77.3
Mirab Welega	86.6	89.6	45.5	152.9
Afar Zone 3	109.7	112.6	74.0	170.8
Misraq Harerge	53.5	55.6	33.4	91.7
Misraq Shewa	55.2	57.6	33.6	92.6
Misraq Wellega	60.5	62.2	34.4	98.7
North Shewa, Oromia	63.5	66.2	35.6	115.3
Afder	73.2	75.5	39.2	130.6
Doolo	75.8	77.9	42.6	131.0
Fafan	70.0	72.1	43.4	109.0
Jarar	70.9	72.4	44.5	109.6
Korahe	85.0	87.5	48.5	143.3
Liben	77.1	80.9	48.1	133.1
Afar Zone 4	80.3	81.6	47.2	120.3
Nogob	68.8	72.7	35.2	128.7
Shabelle	59.3	61.1	34.0	99.4
Siti	74.5	78.3	40.8	144.2
Alaba	59.2	61.7	31.9	106.0
Alle	69.6	73.9	32.1	141.1
Amaro	67.7	71.5	34.1	131.9
Basketo	70.1	76.2	30.7	152.4
Bench Maji	122.3	126.1	72.1	201.3
Burji	55.1	58.2	28.7	106.8
Dawro	61.1	62.9	33.4	104.4
Afar Zone 5	80.4	83.5	50.9	128.5
Debub Omo	73.0	76.2	42.7	122.4
Derashe	61.4	65.3	29.9	123.6
Gamo Gofa	72.5	73.9	43.1	116.2
Gedeo	72.2	75.7	40.4	124.7
Gurage	62.0	63.9	37.3	101.8
Hadiya	65.8	67.2	39.1	106.6
Keffa	66.9	68.7	36.3	113.6
Kembata Tembaro	51.4	53.9	27.0	92.7
Konso	69.4	73.5	34.4	136.2
Konta	95.1	100.2	52.9	176.1
Agew Awi	61.1	64.4	32.4	112.2
Sheka	61.7	66.0	31.0	124.1
Sidama	65.1	66.6	40.9	103.3
Silti	51.6	54.0	27.4	94.3
Wolayita	48.1	49.8	27.6	79.5
Yem	62.4	65.4	30.4	123.6
Debubawi	32.5	33.4	18.9	55.4
Mehakelegnaw	61.8	62.8	38.3	95.9
Mi'irabawi	55.3	58.8	30.1	105.6
Misraqawi	41.3	42.6	21.1	70.0
Semien Mi'irabaw	72.0	75.6	44.6	127.8
Argoba	73.1	78.9	34.5	161.3
Bahir Dar Special Zone	28.6	31.9	10.0	76.5

Table A.9 Summarized U5MR Admin 1 estimates (per 1,000 live births) and 95% uncertainty interval for Kenya DHS 2014

Admin 1 Name	Median	Mean	Lower	Upper
Baringo	36.6	37.6	25.4	53.7
Kajiado	30.7	31.2	21.0	44.7
Kakamega	45.4	46.0	30.8	66.0
Kericho	45.9	46.5	32.5	64.7
Kiambu	42.4	43.3	28.5	62.9
Kilifi	48.6	49.2	33.4	68.6
Kirinyaga	47.7	48.6	31.6	71.2
Kisii	39.6	40.5	28.6	57.0
Kisumu	68.3	68.7	48.7	91.5
Kitui	33.2	33.8	22.8	49.0
Kwale	56.0	56.4	39.1	76.9
Bomet	45.4	46.2	32.0	63.7
Laikipia	32.5	33.2	21.4	48.2
Lamu	53.4	54.4	35.6	80.6
Machakos	40.7	41.5	28.8	58.8
Makueni	30.5	31.1	19.5	45.2
Mandera	22.8	23.6	13.6	39.2
Marsabit	34.9	35.9	23.7	51.4
Meru	53.9	54.7	38.2	78.5
Migori	94.8	96.4	72.5	127.9
Mombasa	48.8	50.4	30.7	77.3
Murang'a	43.1	44.1	29.7	63.6
Bungoma	39.9	40.3	28.1	55.0
Nairobi	65.3	66.0	45.7	93.2
Nakuru	50.2	50.9	35.6	71.7
Nandi	38.5	39.3	26.5	54.9
Narok	35.6	36.4	24.6	50.9
Nyamira	41.4	42.4	28.7	62.7
Nyandarua	57.4	58.3	39.2	81.3
Nyeri	34.9	35.6	22.5	53.5
Samburu	25.7	26.4	16.9	38.7
Siaya	56.6	57.5	39.4	80.2
Taita Taveta	39.9	40.9	26.7	61.7
Busia	64.6	65.8	45.9	90.1
Tana River	65.1	65.6	49.8	84.7
Tharaka-Nithi	30.4	31.3	19.1	47.5
Trans Nzoia	42.8	43.6	29.3	62.5
Turkana	55.0	56.1	39.2	77.5
Uasin Gishu	36.0	36.6	24.7	52.1
Vihiga	68.5	69.3	48.3	95.6
Wajir	36.2	37.0	24.7	54.0
West Pokot	27.3	28.1	18.7	41.9
Elgeyo-Marakwet	33.5	34.2	21.6	49.8
Embu	38.1	39.1	25.6	58.4
Garissa	51.1	51.7	36.2	71.2
Homa Bay	86.2	86.8	63.6	116.2
Isiolo	43.5	44.3	31.1	60.5

Table A.10 Summarized U5MR Admin 2 estimates (per 1,000 live births) and 95% uncertainty interval for Kenya DHS 2014

Admin 2 Name	Median	Mean	Lower	Upper
Chepalungu	44.1	45.6	26.5	73.7
Ndia	42.0	44.2	21.0	80.0
Bobasi	43.5	45.4	25.5	76.8
Bomachoge Borabu	47.7	49.8	24.2	88.5
Bomachoge Chache	50.9	53.3	25.0	100.6
Bonchari	44.9	46.8	25.9	77.7
Kitutu Chache North	43.8	46.4	22.5	83.0
Kitutu Chache South	37.5	39.9	20.4	73.0
Nyaribari Chache	35.8	37.1	19.1	63.6
Nyaribari Masaba	35.4	37.1	19.5	62.1
South Mugirango	48.8	50.8	28.2	84.6
Konoin	37.8	39.7	22.7	65.7
Kisumu Central	64.3	67.8	35.4	117.5
Kisumu East	69.3	72.2	39.4	115.2
Kisumu West	80.8	83.6	51.3	130.4
Muhoroni	54.5	56.3	32.9	90.0
Nyakach	65.1	68.2	36.1	116.1
Nyando	59.0	60.3	35.7	95.4
Seme	76.0	78.6	47.2	124.1
Kitui Central	32.2	34.1	17.7	62.4
Kitui East	40.9	41.7	21.8	68.2
Kitui Rural	33.9	35.4	19.5	60.8
Sotik	47.0	48.8	25.7	84.1
Kitui South	34.6	36.0	18.7	60.0
Kitui West	26.7	28.5	12.8	55.1
Mwingi Central	36.6	38.1	20.2	66.4
Mwingi North	44.1	45.8	25.3	75.3
Mwingi West	32.4	34.1	17.2	60.7
Kinango	44.4	45.6	25.3	71.6
Lungalunga	63.5	66.1	34.4	109.2
Matuga	50.6	52.8	27.5	87.2
Msambweni	65.5	68.8	35.1	116.2
Laikipia East	35.5	36.3	18.9	60.8
Bumula	49.8	52.1	27.8	87.2
Laikipia North	26.8	28.0	15.0	47.1
Laikipia West	33.2	33.9	19.3	52.4
Lamu East	57.7	60.9	25.2	118.1
Lamu West	55.4	57.0	36.9	88.6
Kangundo	40.6	43.2	18.9	83.3
Kathiani	39.4	41.5	21.2	73.2
Machakos Town	40.2	41.6	22.9	70.8
Masinga	39.2	40.7	21.8	68.8
Matungulu	37.9	39.5	20.8	65.2
Mavoko	43.0	44.2	24.3	71.8
Kabuchai	31.7	33.7	16.3	60.9
Mwala	31.9	33.4	17.7	59.9
Yatta	45.1	47.8	25.0	86.1
Kaiti	38.6	40.5	19.2	74.0
Kibwezi East	35.1	36.6	18.9	63.2
Kibwezi West	30.4	31.6	16.2	53.5
Kilome	31.6	32.8	16.8	58.4
Makueni	33.8	35.5	18.9	62.5
Mbooni	28.7	30.5	15.3	54.4
Banissa	16.8	18.3	6.8	40.9
Kanduyi	34.8	35.9	20.1	58.9
Lafey	20.6	22.3	8.8	44.3
Mandera East	23.5	26.4	9.6	60.2
Mandera North	20.5	22.2	10.2	43.6
Mandera South	28.6	29.8	14.6	52.3
Mandera West	17.2	18.3	8.0	34.3
Laisamis	27.9	28.5	15.2	47.8
Moyale	38.6	40.9	21.3	71.0
North Horr	36.8	38.3	21.3	63.2
Saku	36.3	38.0	17.6	69.0
Kimilili	42.1	44.3	23.5	76.8
Buuri	37.1	38.5	21.8	61.9
Central Imenti	35.0	36.5	19.3	64.4
Igembe Central	63.6	66.0	34.9	111.3
Igembe North	44.9	47.7	22.8	89.0
Igembe South	58.1	59.9	32.3	97.4
North Imenti	36.6	39.4	19.1	72.8
South Imenti	41.1	42.9	22.0	75.4
Tigania East	51.0	54.2	31.1	93.7
Tigania West	34.4	36.6	17.8	64.1
Likuyani	34.8	36.5	17.1	64.6
Awendo	73.1	75.2	41.0	125.6
Kuria East	52.2	56.2	25.7	111.3
Kuria West	56.3	59.2	33.1	103.5
Nyatike	98.9	101.3	61.0	152.1
Rongo	93.5	96.0	59.4	148.6
Suna East	122.0	127.0	71.1	212.9
Suna West	104.9	107.7	63.3	166.2
Uriri	106.2	110.0	66.4	165.3
Changamwe	49.0	52.4	24.6	96.7
Jomvu	38.1	40.9	17.3	77.9
Lugari	34.6	36.7	16.2	70.8
Kisauni	41.9	44.6	21.1	80.4
Likoni	60.2	65.6	26.7	130.1
Mvita	48.9	54.1	21.2	112.8
Nyali	40.5	44.9	15.6	94.6
Gatanga	44.6	46.1	26.4	77.7
Kandara	57.4	60.2	29.4	105.4
Kangema	40.7	42.9	19.6	79.5
Kigumo	37.5	39.2	20.0	66.1
Kiharu	40.0	41.8	22.2	71.8
Maragwa	38.2	39.7	20.9	66.5
Mt. Elgon	41.8	43.5	22.3	75.5
Mathioya	43.1	46.2	20.0	89.8
Dagoretti North	58.4	62.1	28.6	119.9
Dagoretti South	55.7	58.0	29.8	102.7
Embakasi Central	53.4	59.5	24.5	127.2
Embakasi East	47.5	49.2	25.5	82.2
Embakasi North	59.4	62.8	30.9	118.9
Embakasi South	43.6	46.0	23.7	81.2
Embakasi West	57.8	60.3	29.3	108.5
Kamukunji	58.4	61.8	30.8	111.7
Kasarani	57.5	59.7	33.1	99.4
Baringo Central	41.2	42.7	21.5	74.6
Sirisia	48.5	51.4	27.0	90.5
Kibra	76.9	81.9	38.1	150.3
Langata	54.0	56.1	30.2	94.3
Makadara	70.0	73.7	34.3	133.0
Mathare	64.9	67.8	32.4	121.3
Roysambu	59.2	62.0	31.3	111.5
Ruaraka	55.0	59.8	24.5	119.7
Starehe	55.7	58.2	29.9	99.4
Westlands	51.5	53.1	28.0	88.7
Bahati	50.1	51.6	27.3	85.6
Gilgil	49.1	50.5	26.4	84.1
Tongaren	31.9	34.0	16.0	62.8
Kuresoi North	37.2	38.6	20.2	67.3
Kuresoi South	37.2	39.7	19.2	73.0
Molo	42.4	44.0	22.1	78.5
Naivasha	43.0	44.6	25.3	73.2
Nakuru Town East	58.1	60.2	29.5	106.0
Nakuru Town West	64.3	68.8	33.6	126.7

(Continues…)

Table A.10—*Continued*

Admin 2 Name	Median	Mean	Lower	Upper
Njoro	66.6	69.2	38.6	116.2
Rongai	39.2	40.5	21.3	68.7
Subukia	41.2	42.7	21.5	73.4
Aldai	52.3	54.6	31.6	90.8
Webute West	35.7	37.1	18.6	66.7
Chesumei	38.3	40.3	20.7	73.4
Emgwen	36.3	37.7	21.1	61.1
Mosop	35.9	37.7	19.0	65.2
Nandi Hills	41.3	42.7	22.8	69.3
Tinderet	39.3	40.9	21.2	68.3
Emurua Dikirr	37.3	39.8	20.2	72.3
Kilgoris	46.5	48.3	29.3	76.7
Narok East	30.8	32.2	15.8	55.9
Narok North	46.6	47.8	29.2	77.5
Narok South	33.2	34.4	19.9	55.6
Webuye East	41.6	44.0	22.7	76.4
Narok West	40.0	41.9	19.9	77.0
Borabu	36.6	38.0	21.5	64.7
Kitutu Masaba	31.9	33.5	17.1	59.2
North Mugirango	72.0	74.7	39.8	124.8
West Mugirango	40.1	41.9	24.0	71.4
Kinangop	48.4	49.7	28.2	79.7
Kipipiri	41.1	42.9	23.3	77.3
Ndaragwa	44.1	46.4	24.2	85.7
Ol Jorok	49.4	51.5	28.8	88.0
Ol Kalou	60.2	63.2	32.7	108.5
Budalangi	85.3	88.5	47.9	145.5
Kieni	34.8	36.3	20.4	59.4
Mathira	37.7	39.6	21.1	66.7
Mukurweini	40.2	42.5	20.4	76.8
Nyeri Town	37.6	39.8	18.7	73.7
Othaya	35.1	36.6	17.5	68.5
Tetu	38.7	40.9	21.5	74.5
Samburu East	27.2	28.2	15.3	47.0
Samburu North	23.1	24.1	12.5	41.5
Samburu West	27.3	28.0	16.0	44.3
Alego Usonga	60.1	62.0	32.7	97.3
Butula	52.9	55.2	27.0	96.6
Bondo	51.8	53.1	30.0	88.1
Gem	58.1	59.4	34.7	93.4
Rarieda	76.6	78.2	46.6	122.4
Ugenya	49.3	51.5	27.0	87.4
Ugunja	55.2	57.8	30.8	101.2
Mwatate	47.9	50.4	26.4	89.9
Taveta	35.6	37.3	17.2	72.0
Voi	39.1	39.9	22.6	63.7
Wundanyi	40.8	43.2	20.1	78.6
Bura	69.3	70.4	46.7	101.7
Funyula	62.1	63.7	30.1	114.6
Galole	51.6	52.3	31.2	79.6
Garsen	57.2	58.4	38.2	86.0
Chuka/Igambang'Ombe	33.2	34.4	18.8	57.6
Igembe South	38.9	41.0	18.9	79.5
Maara	40.3	42.2	20.9	74.0
Tharaka	33.9	35.4	18.8	59.2
Cherangany	29.4	30.8	16.9	51.2
Endebess	51.4	53.9	27.9	94.3
Kiminini	35.0	36.1	19.9	58.6
Kwanza	39.7	41.3	20.7	73.3
Matayos	55.5	57.8	32.3	94.6
Saboti	47.0	49.0	26.6	81.6
Loima	43.2	44.8	24.0	78.0
Turkana Central	40.1	41.2	23.0	64.7
Turkana East	46.7	48.6	26.5	87.3
Turkana North	51.0	52.3	23.9	90.5
Turkana South	52.0	54.1	29.6	92.9
Turkana West	44.7	47.3	23.6	87.3
Ainabkoi	34.1	35.7	17.9	61.6
Nambale	59.9	62.7	33.2	109.5
Kapseret	31.8	33.0	16.3	58.0
Kesses	34.2	35.5	18.8	59.3
Moiben	36.5	38.0	19.6	66.0
Soy	35.2	36.7	20.1	61.5
Turbo	39.5	41.5	23.6	70.6
Emuhaya	69.2	71.9	38.1	122.6
Hamisi	68.6	70.8	41.2	112.6
Luanda	75.8	78.1	46.6	122.6
Sabatia	65.6	68.2	38.0	112.6
Vihiga	60.8	63.8	33.7	107.7
Teso North	54.4	57.3	29.5	100.6
Eldas	32.5	33.8	18.3	57.3
Tarbaj	25.0	26.4	12.4	49.3
Wajir East	37.6	38.5	20.4	61.8
Wajir North	25.3	26.9	11.8	48.7
Wajir South	34.0	35.1	17.6	58.3
Wajir West	37.8	40.0	18.5	76.7
Kacheliba	29.0	30.7	15.1	54.1
Kapenguria	30.6	31.8	19.2	50.7
Pokot South	29.6	30.6	17.4	49.4
Sigor	31.4	32.5	17.3	55.0
Baringo North	38.4	40.3	20.6	67.2
Teso South	66.7	68.9	39.8	112.8
Keiyo North	35.5	37.1	21.6	61.2
Keiyo South	38.2	39.6	22.1	65.7
Marakwet East	29.7	31.3	15.3	56.3
Marakwet West	29.5	31.2	16.8	53.2
Manyatta	41.4	42.9	25.5	67.4
Mbeere North	46.4	48.4	25.5	84.4
Mbeere South	35.6	37.0	20.9	63.0
Runyenjes	32.0	33.3	17.2	56.6
Balambala	51.4	53.2	26.4	91.1
Baringo South	32.5	34.0	17.3	59.1
Daadab	60.1	62.5	34.1	102.8
Fafi	59.6	62.1	34.0	101.6
Garissa Township	60.1	62.3	36.6	98.9
Ijara	50.6	53.1	28.9	87.6
Lagdera	35.5	36.9	19.5	61.3
Homa Bay Town	85.5	88.6	51.6	139.6
Kabondo Kasipul	58.5	61.5	33.2	103.7
Karachuonyo	77.1	79.9	44.5	123.3
Kasipul	57.8	59.7	33.9	97.4
Mbita	72.5	75.4	41.4	126.2
Eldama Ravine	37.4	38.9	22.4	65.7
Ndhiwa	93.8	95.2	55.9	143.2
Rangwe	71.7	74.6	41.4	120.5
Suba	95.4	97.4	58.3	152.8
Isiolo North	34.7	35.6	22.4	54.8
Isiolo South	66.7	69.0	44.3	104.3
Kajiado Central	27.1	28.8	15.1	50.4
Kajiado East	31.3	32.7	18.8	54.0
Kajiado North	36.2	37.6	18.0	68.1
Kajiado South	38.8	40.5	21.8	67.7
Mogotio	35.0	36.3	17.9	64.8
Kajiado West	31.2	32.5	18.1	54.7
Butere	49.3	51.7	27.2	92.3
Ikolomani	64.4	68.4	35.6	120.6
Khwisero	63.3	66.9	30.7	123.2
Lugari	34.5	36.6	18.8	64.2
Lurambi	52.8	54.6	28.8	91.2
Malava	38.5	40.5	21.3	69.4

(Continues…)

Table A.10—*Continued*

Admin 2 Name	Median	Mean	Lower	Upper
Matungu	48.5	50.2	27.1	84.3
Mumias East	44.4	46.6	22.3	87.2
Mumias West	43.9	45.8	23.7	79.2
Tiaty	34.8	36.1	21.4	57.9
Navakholo	37.3	39.8	19.8	70.7
Shinyalu	48.2	50.0	26.3	83.0
Ainamoi	50.8	52.5	26.8	88.2
Belgut	44.4	45.7	24.4	74.6
Bureti	43.9	45.4	23.8	76.2
Kipkelion East	35.6	37.0	20.8	60.9
Kipkelion West	50.3	53.4	26.2	98.3
Sigowet/Soin	53.8	55.2	30.2	91.1
Gatundu North	39.6	41.8	19.0	76.2
Gatundu South	37.3	39.7	16.9	75.3
Bomet Central	41.3	43.8	24.1	75.2
Githunguri	41.6	43.4	22.0	76.3
Juja	39.0	41.0	20.1	72.4
Kabete	43.4	45.9	20.6	89.8

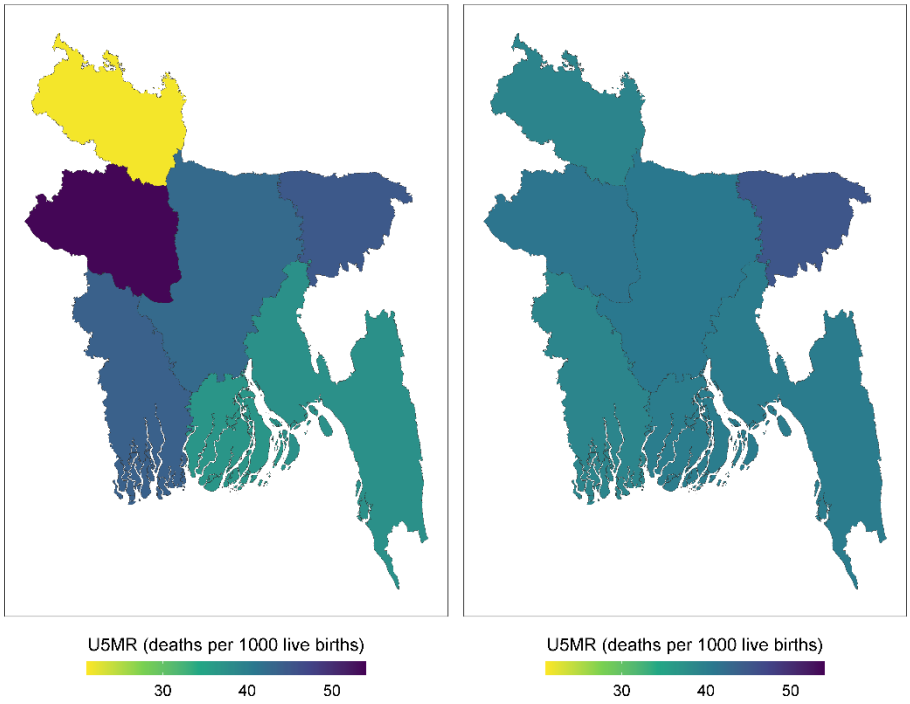
Admin 2 Name	Median	Mean	Lower	Upper
Kiambaa	44.5	46.8	21.9	85.2
Kiambu	45.4	48.6	22.4	95.2
Kikuyu	45.2	47.9	23.1	87.2
Lari	45.8	47.4	25.3	78.7
Limuru	38.9	40.8	20.2	73.2
Ruiru	44.0	46.7	23.6	84.8
Thika Town	47.2	49.7	25.1	83.0
Bomet East	41.8	43.7	23.4	74.6
Ganze	45.2	47.3	25.2	79.9
Kaloleni	36.5	38.6	20.5	66.6
Kilifi North	44.1	45.8	23.0	81.5
Kilifi South	50.0	52.6	30.1	92.6
Magarini	54.1	57.2	30.1	101.9
Malindi	54.1	56.1	28.8	93.5
Rabai	35.7	38.1	18.6	70.4
Gichugu	36.4	38.1	19.8	64.5
Kirinyaga Central	38.9	41.3	20.7	73.5
Mwea	49.5	50.9	30.0	84.0

Table A.11 Summarized U5MR Admin 1 estimates (per 1,000 live births) and 95% uncertainty interval for Malawi DHS 2015

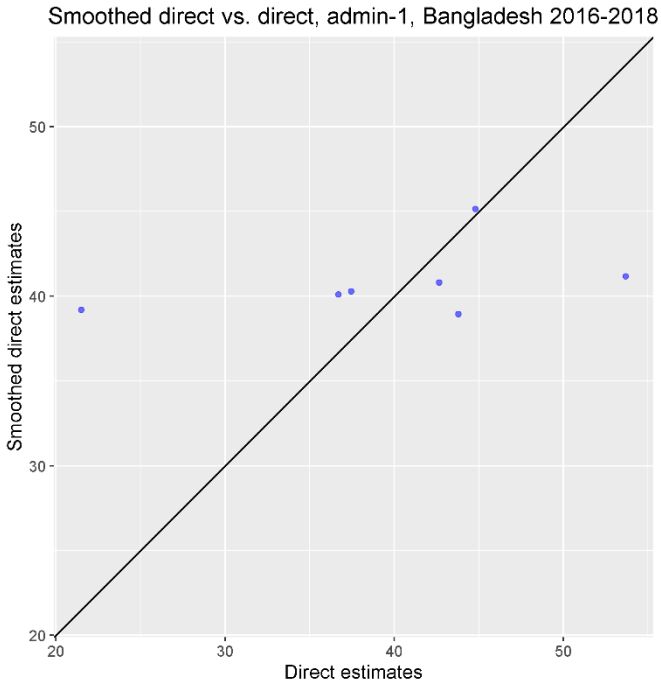
Admin 1 Name	Median	Mean	Lower	Upper
Central	60.2	60.6	49.2	74.1
Northern	46.6	46.8	36.5	58.6
Southern	55.7	55.9	45.3	67.3

APPENDIX B DETAILED RESULTS FOR BANGLADESH

Figure B.1 Comparison of Admin 1 direct and smoothed direct estimates for Bangladesh 2016-2018



(a) Direct estimates (b) Smoothed direct estimates



(c) Direct versus smoothed direct estimates

Figure B.2 **Aggregated yearly beta-binomial national estimates versus yearly direct national estimates, over time, and with 95% error bands. The aggregation is from Admin 2 to national.**

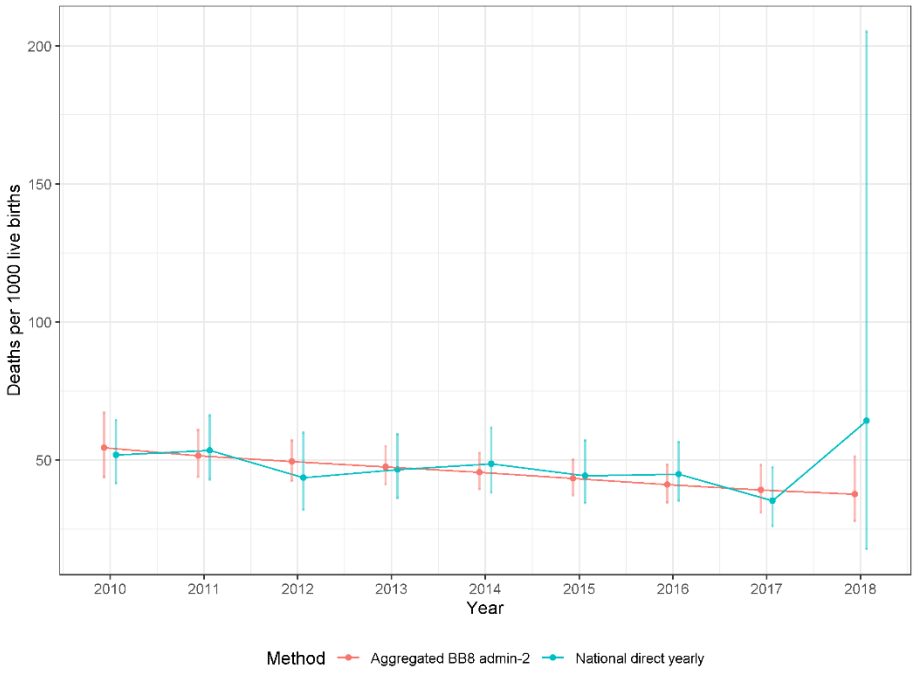


Figure B.3 **Probability for Admin 2 U5MR estimates exceeding national direct estimates for Bangladesh 2018. National rate over the period 2016-2018 (and its associated 95% CI) is 40.7 (33.8, 49.0) per 1,000 live births.**

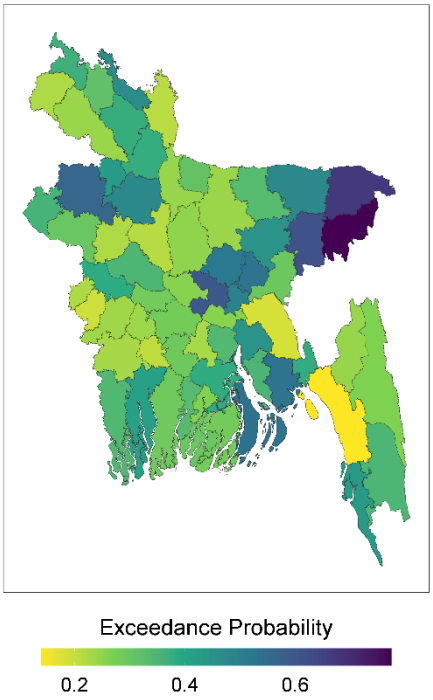


Figure B.4 Odds ratios (urban/rural) over time for the age bands 0-1 months, 1-12 months, >12 months

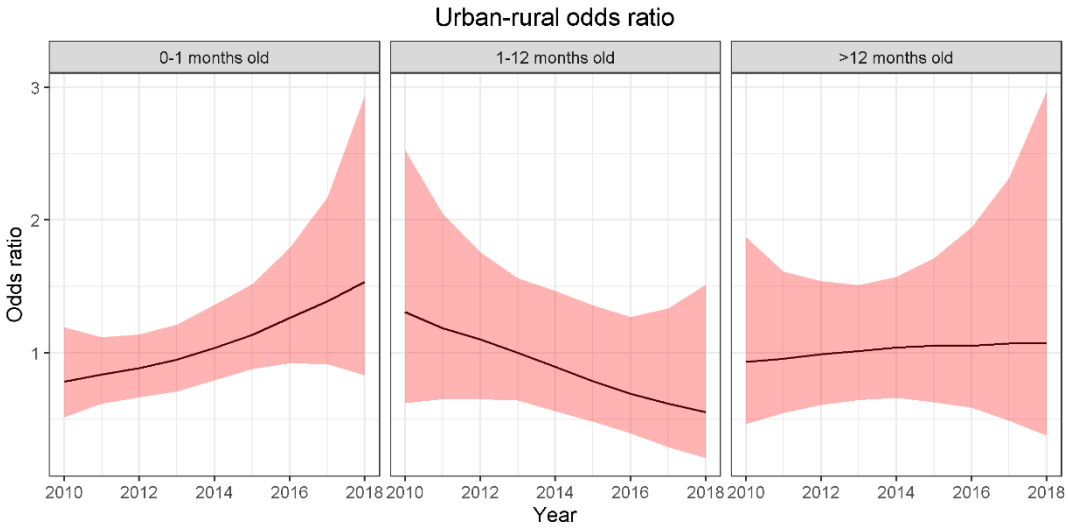


Figure B.5 Bangladesh Admin 1 U5MR estimates for 2010-2018

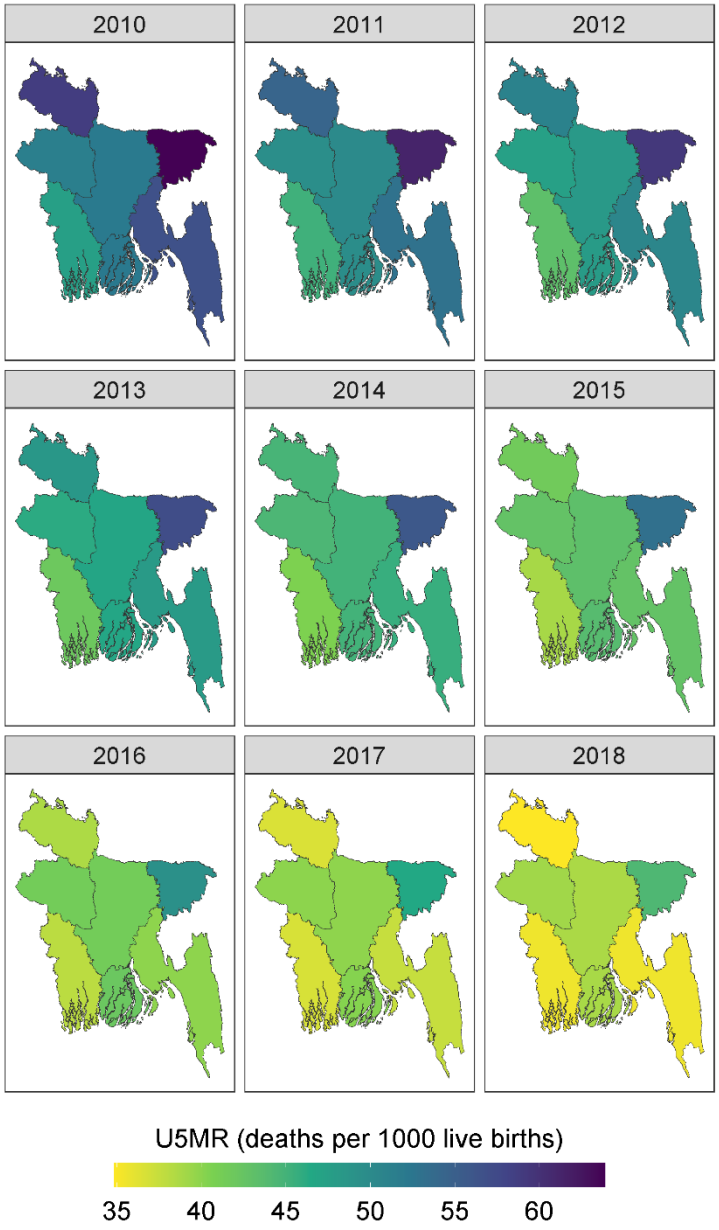


Figure B.6 Bangladesh Admin 1 U5MR 95% credible interval width for 2010-2018

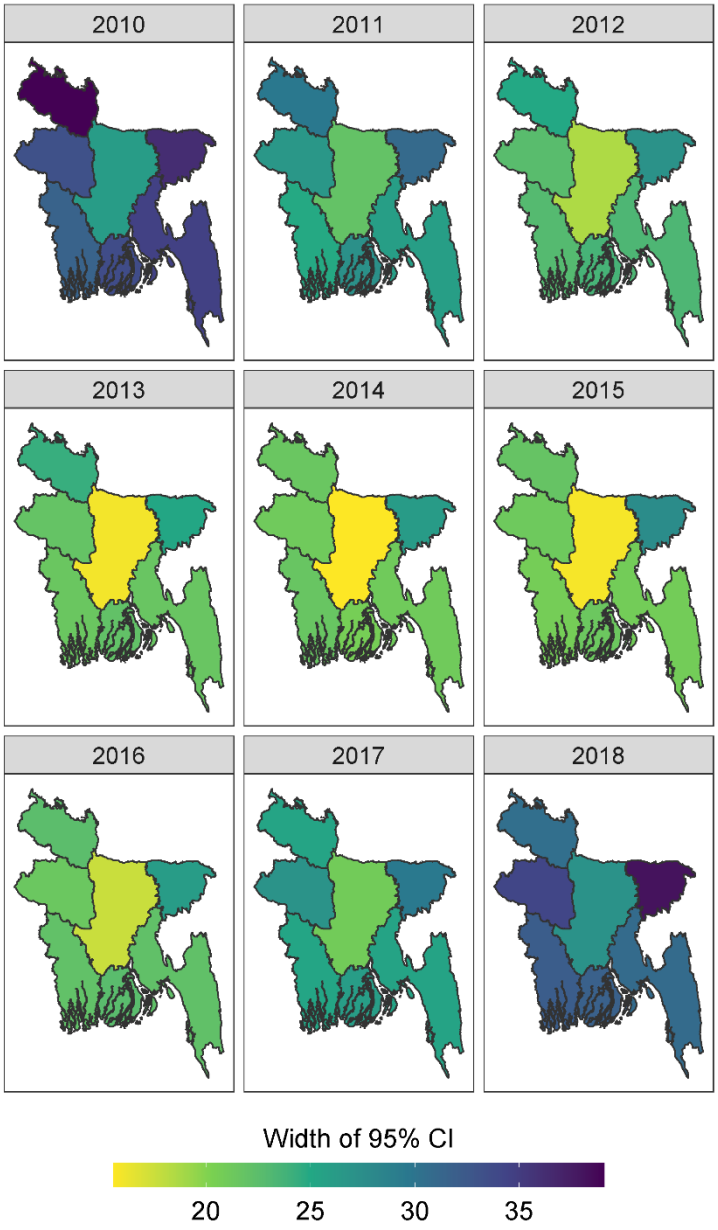


Figure B.7 Bangladesh Admin 1 U5MR estimates by year with associated 95% credible intervals for 2010-2018

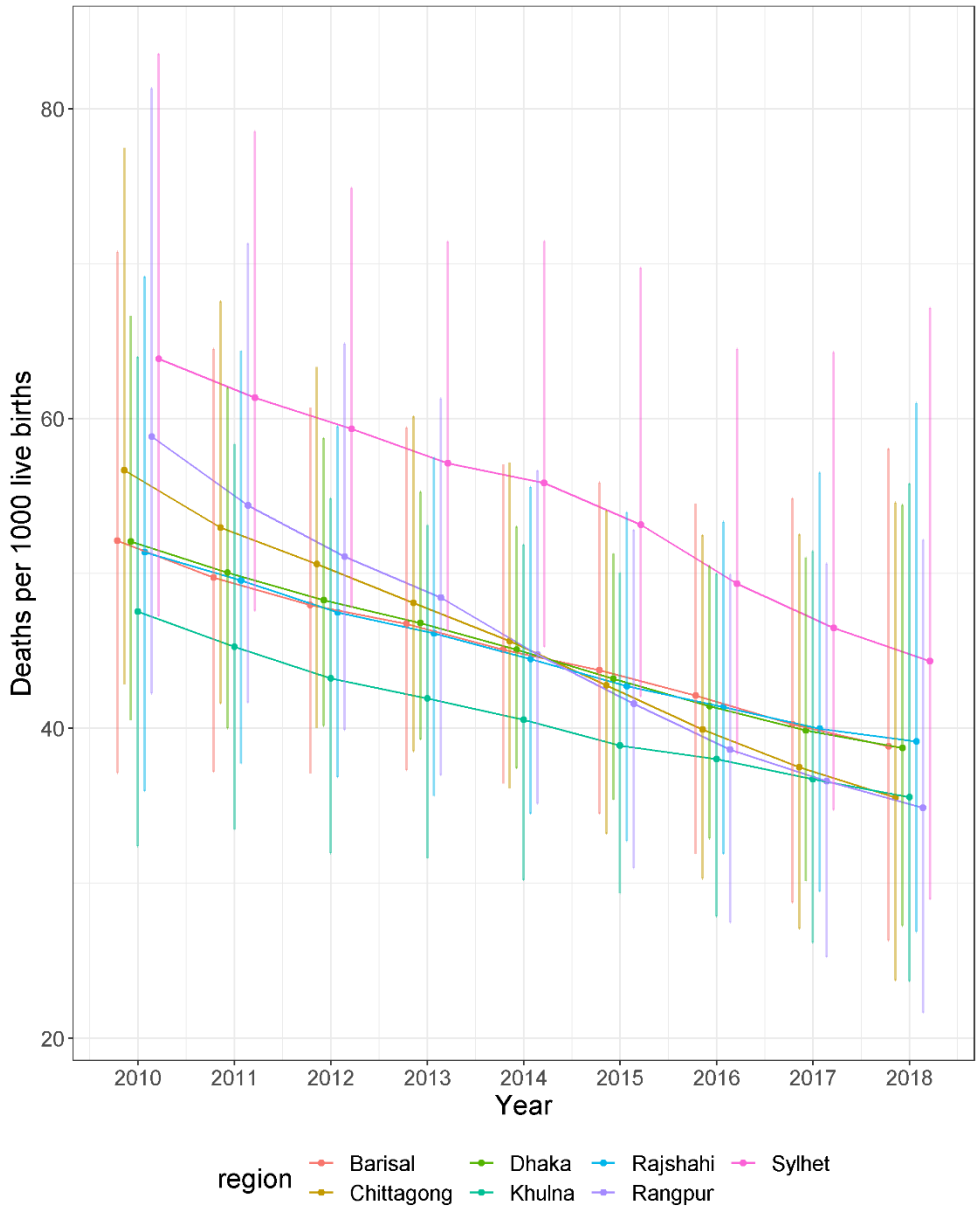


Figure B.8 Bangladesh Admin 2 U5MR estimates for 2010-2018

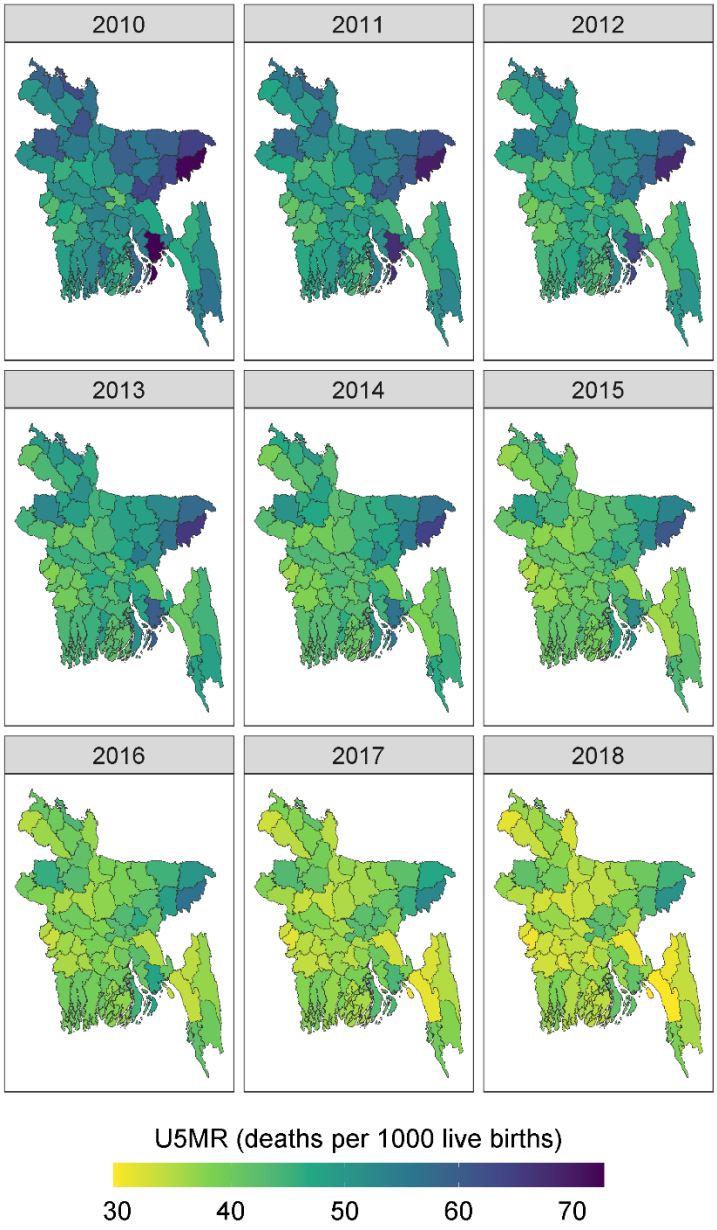


Figure B.9 Bangladesh Admin 2 U5MR 95% credible interval width for 2010-2018

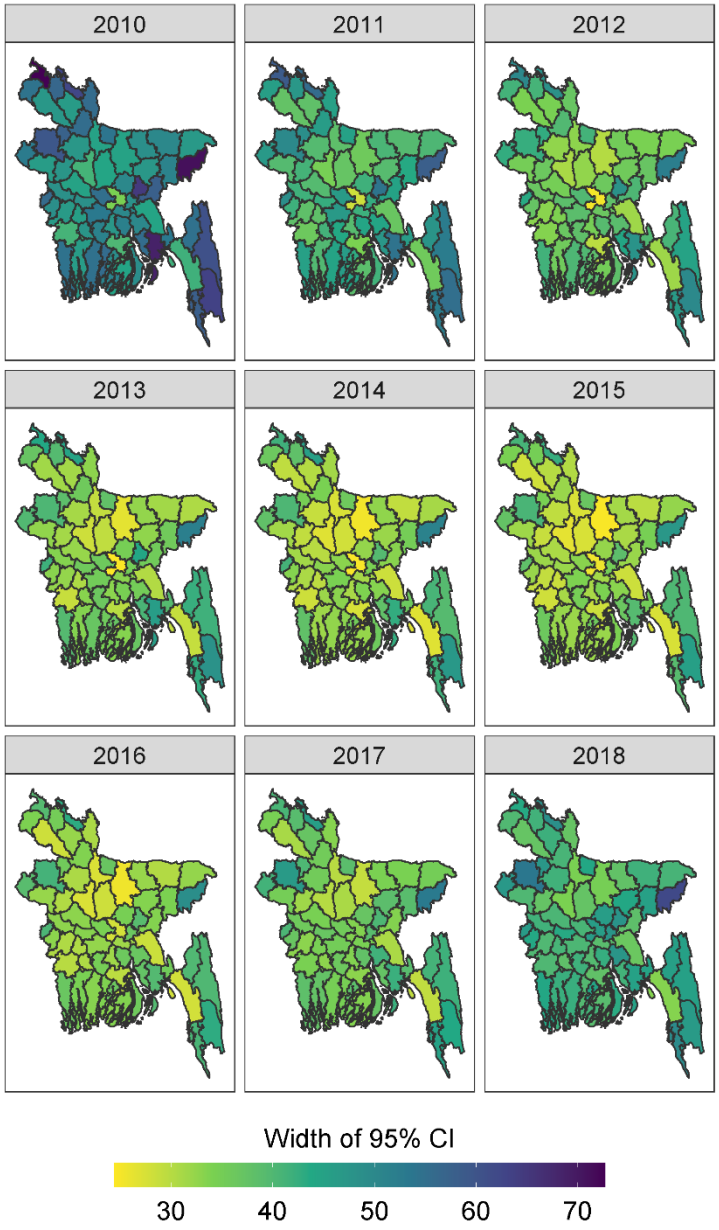


Figure B.10 Bangladesh Admin 2 U5MR estimates by year for 2010-2018

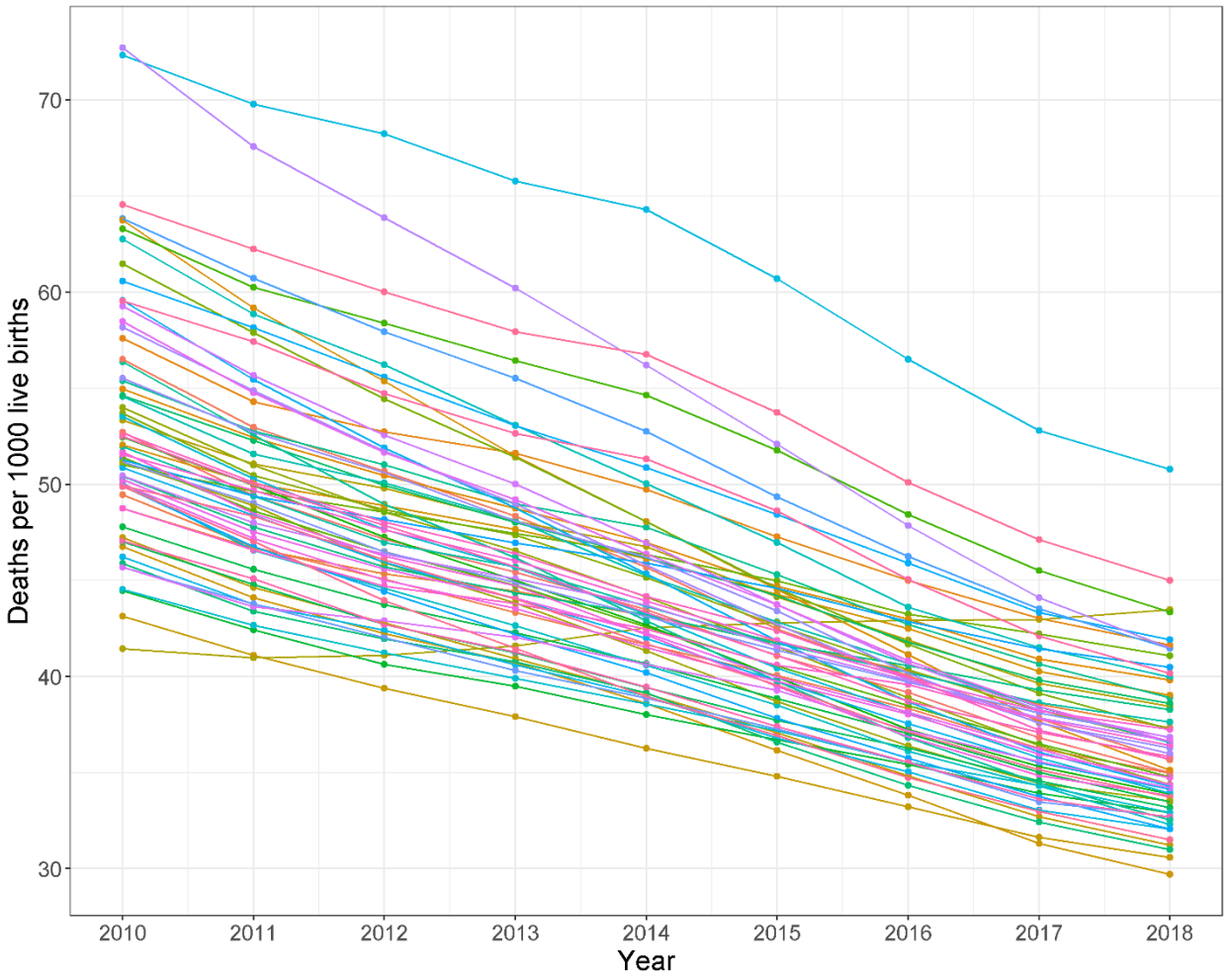


Figure B.11 **Ridgeplot representation of posterior distribution of Admin 2 U5MR for Bangladesh in 2018. On the top we show the regions with the lowest posterior median U5MR, and on the bottom those with the highest U5MR.**

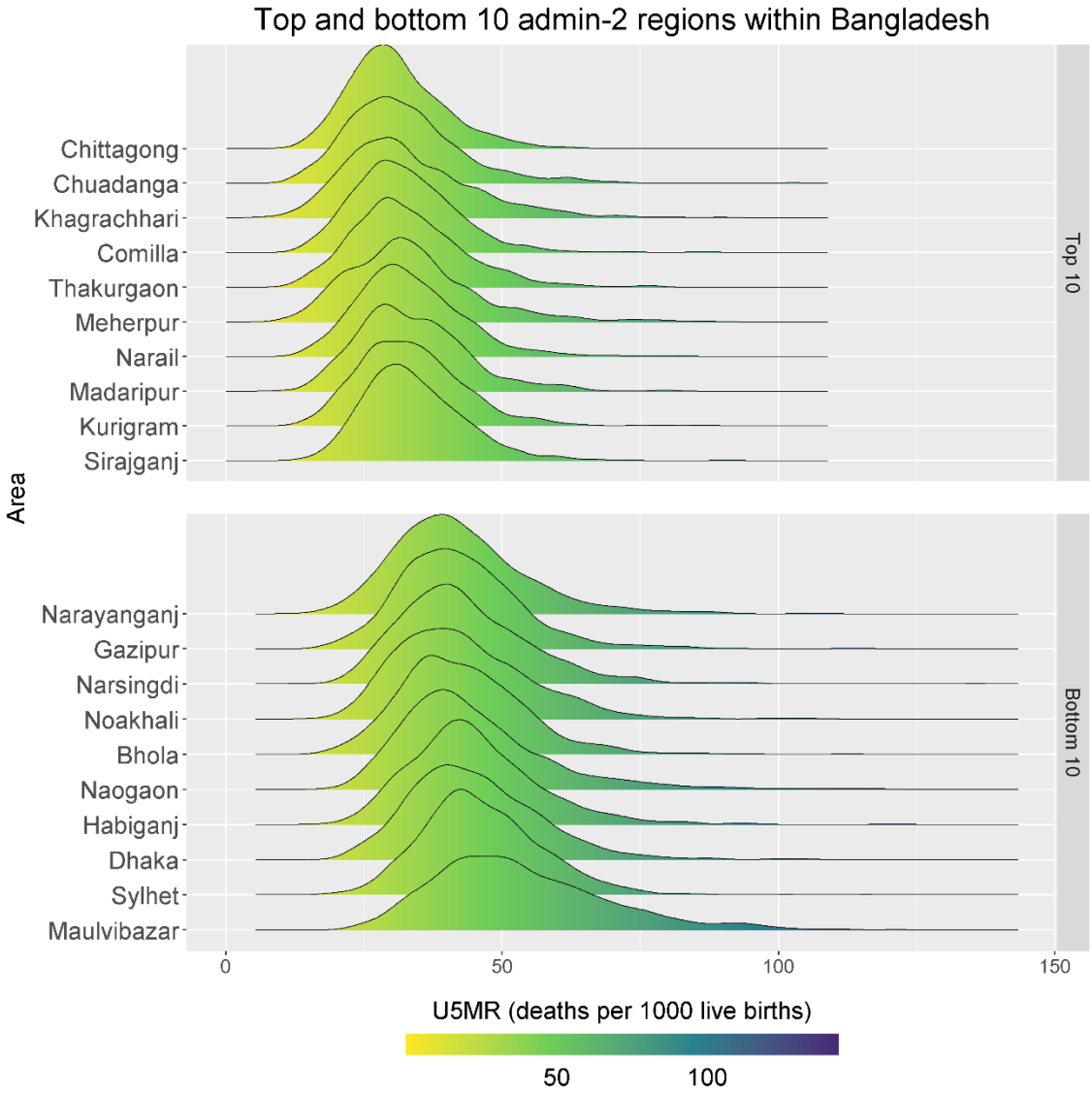


Figure B.12 Estimated Admin 2 U5MR ranking for Bangladesh in 2018. On the left we show the regions with the highest U5MR, and on the right those with the lowest U5MR. The expected ranking (ER) of each area is also given.

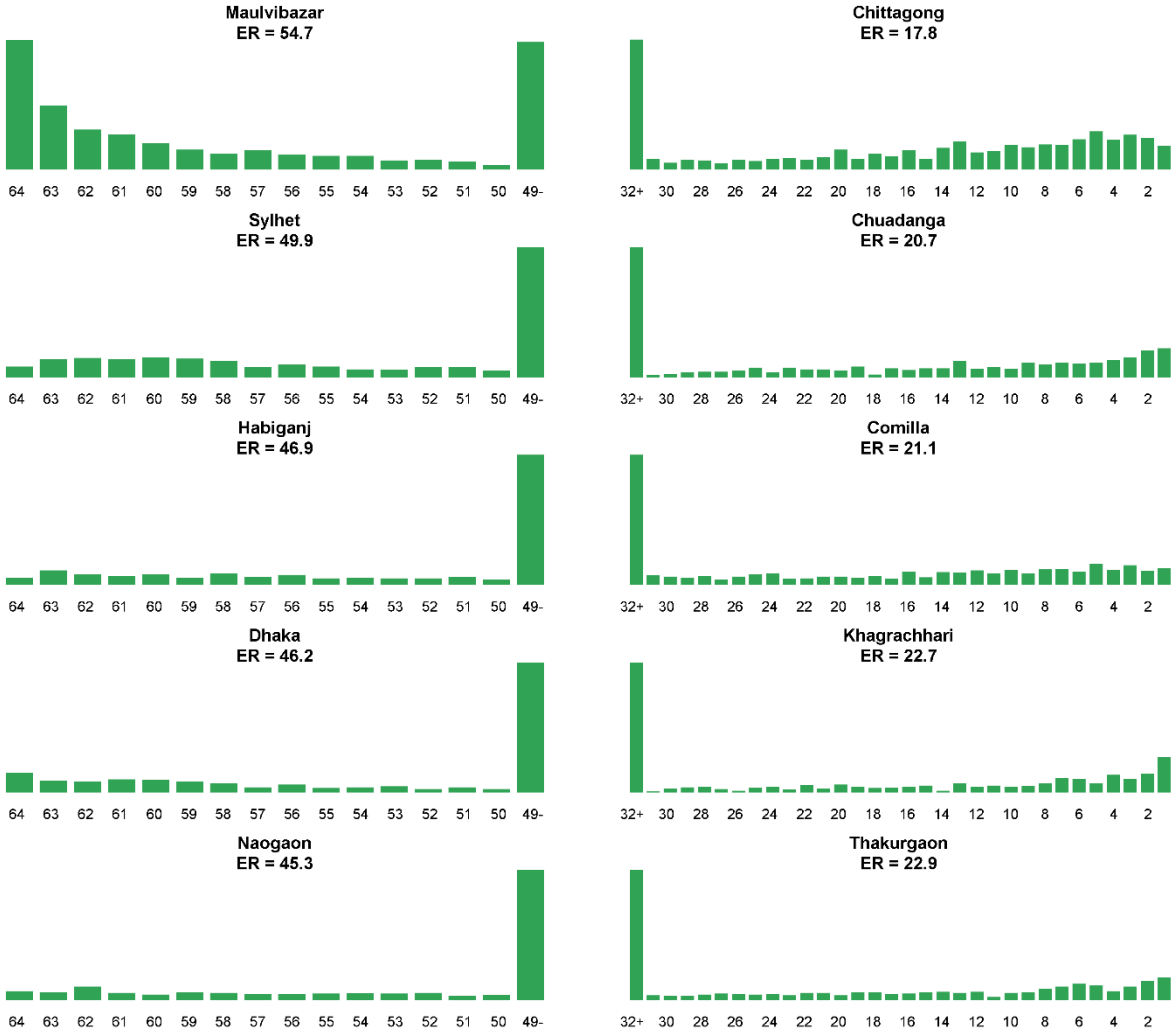
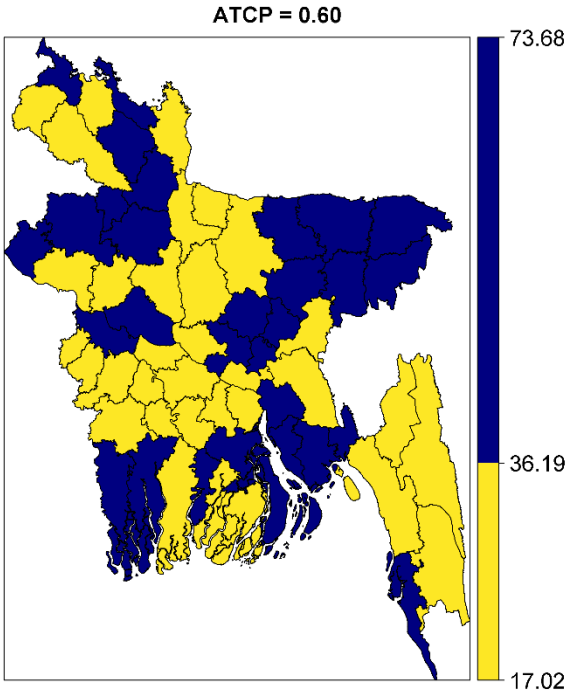
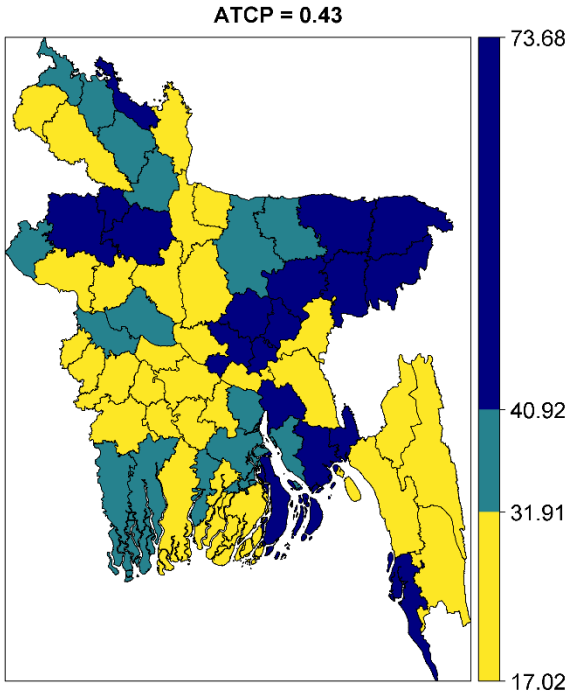


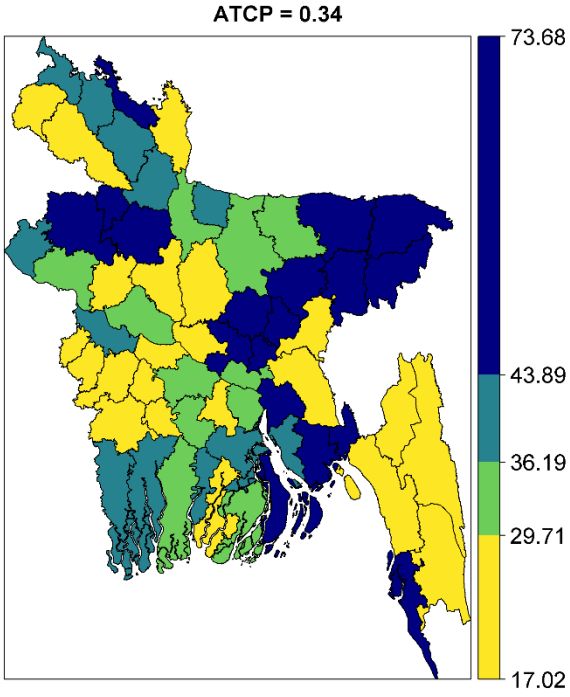
Figure B.13 Average True Classification Probabilities (ATCP) for K = 2, 3, 4 for Bangladesh in 2018, where K is the number of colors on maps



(a) $K = 2$



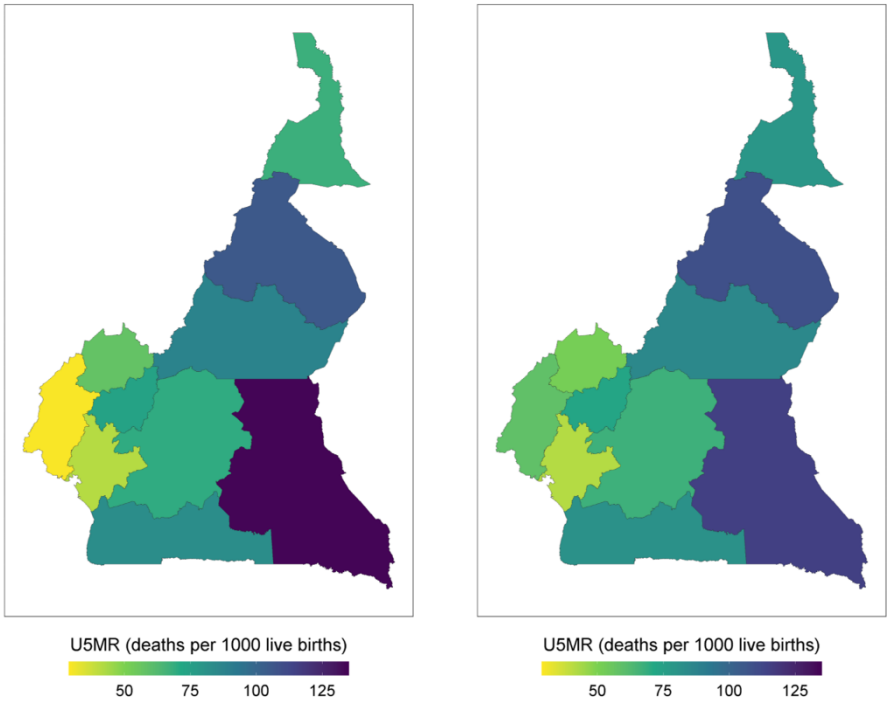
(b) $K = 3$



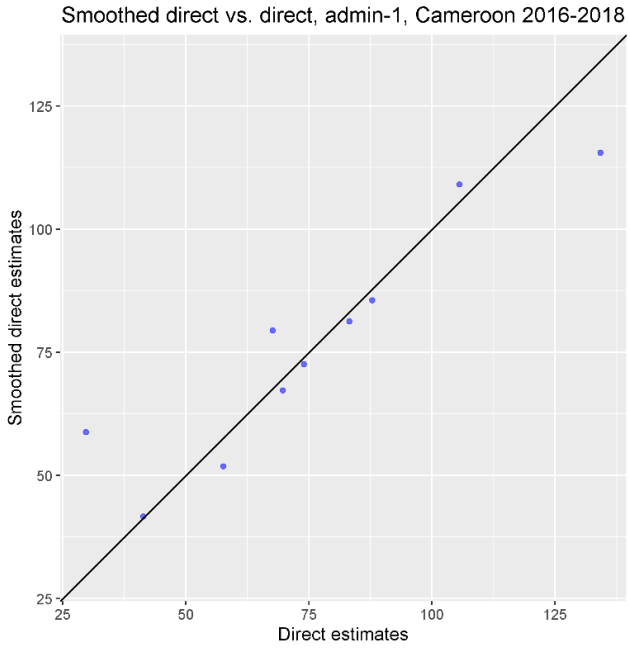
(c) $K = 4$

APPENDIX C DETAILED RESULTS FOR CAMEROON

Figure C.1 Comparison of Admin 1 direct and smoothed direct estimates for Cameroon 2016-2018



(a) Direct estimates (b) Smoothed direct estimates



(c) Direct versus smoothed direct estimates

Figure C.2 **Aggregated yearly beta-binomial national estimates versus yearly direct national estimates, over time, and with 95% error bands. The aggregation is from Admin 2 to national.**

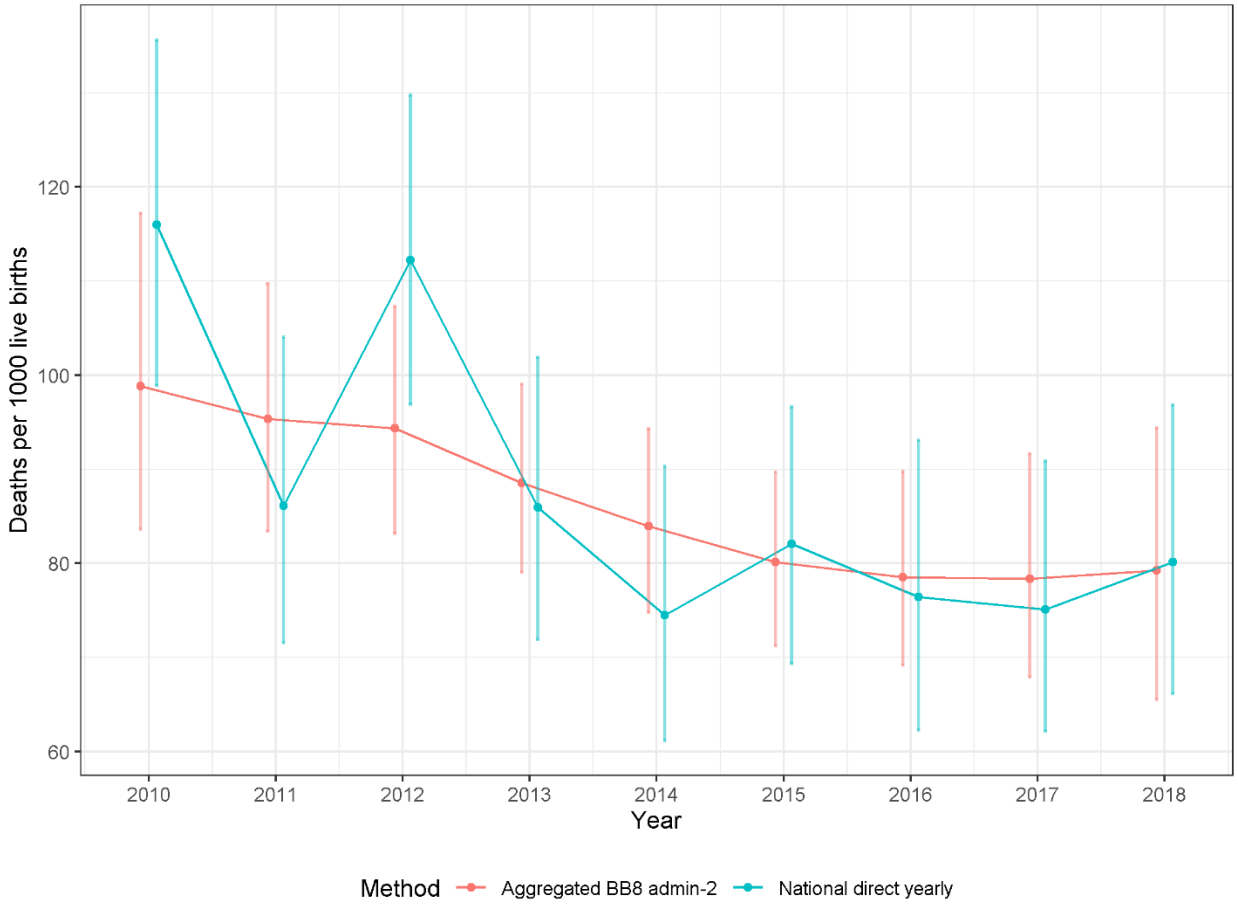


Figure C.3 Probability for Admin 2 U5MR estimates exceeding national direct estimates for Cameroon 2018. National rate over the period 2016-2018 (and its associated 95% CI) is 76.9 (68.3, 86.3) per 1,000 live births.

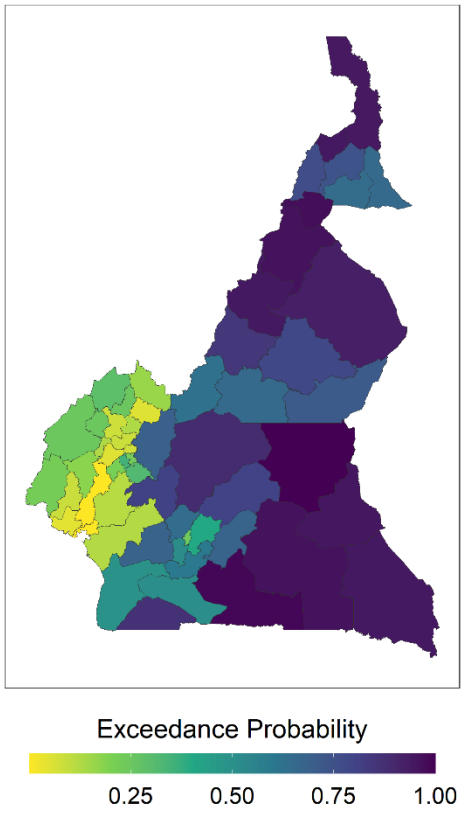


Figure C.4 Odds ratios (urban/rural) over time for the age bands 0-1 months, 1-12 months, >12 months

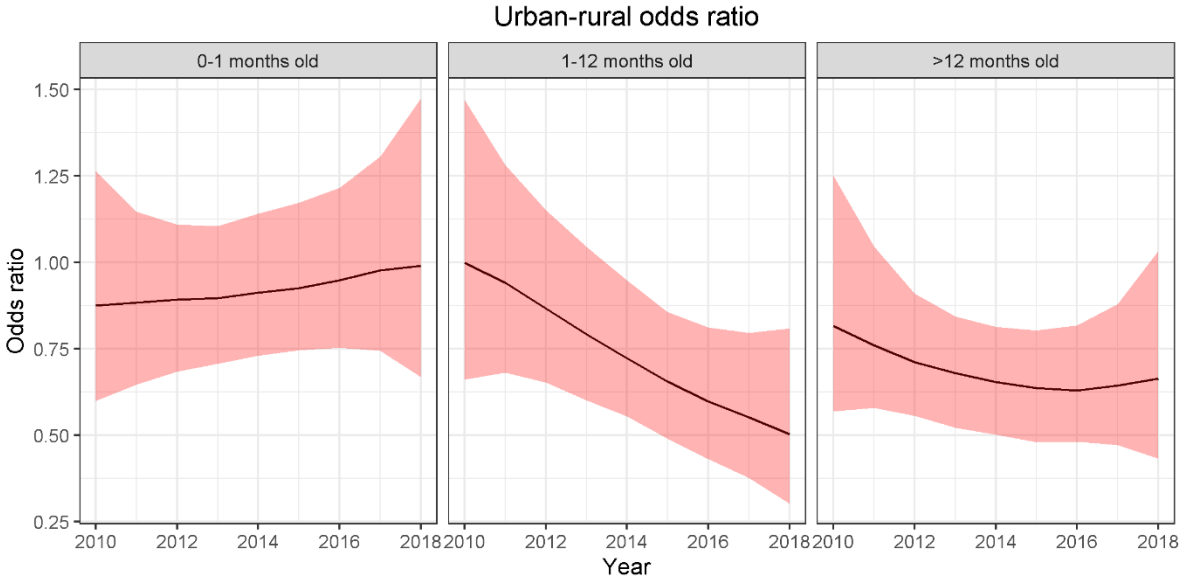


Figure C.5 Cameroon Admin 1 U5MR estimates for 2010-2018

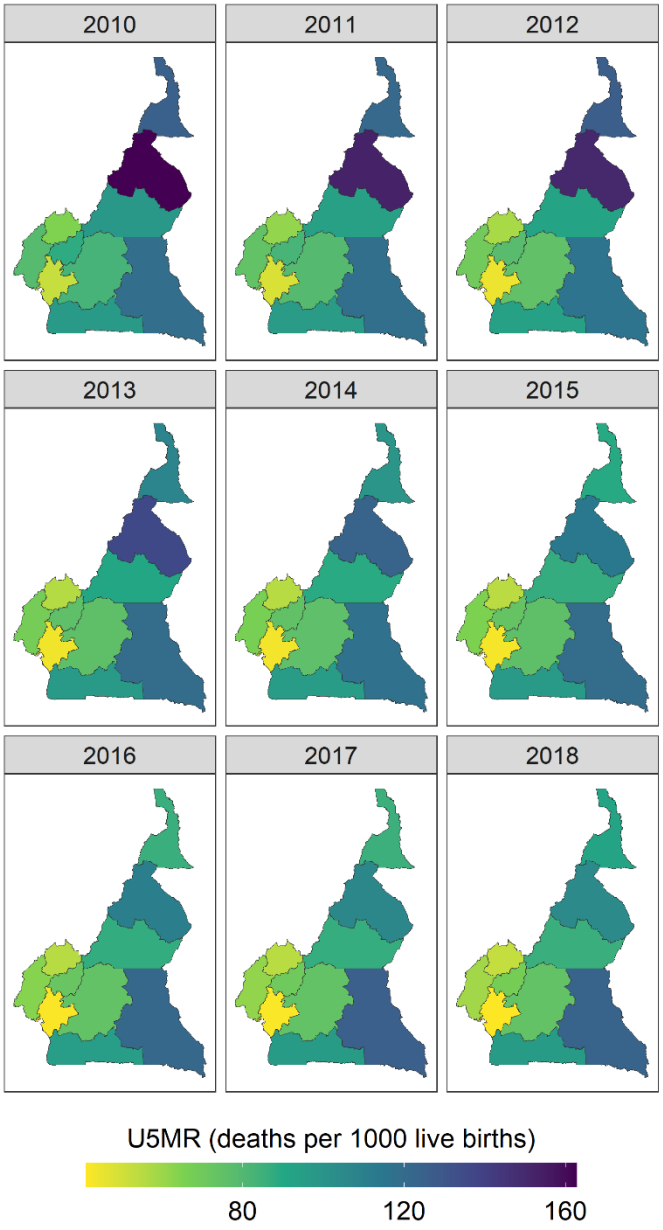


Figure C.6 Cameroon Admin 1 U5MR 95% credible interval width for 2010-2018

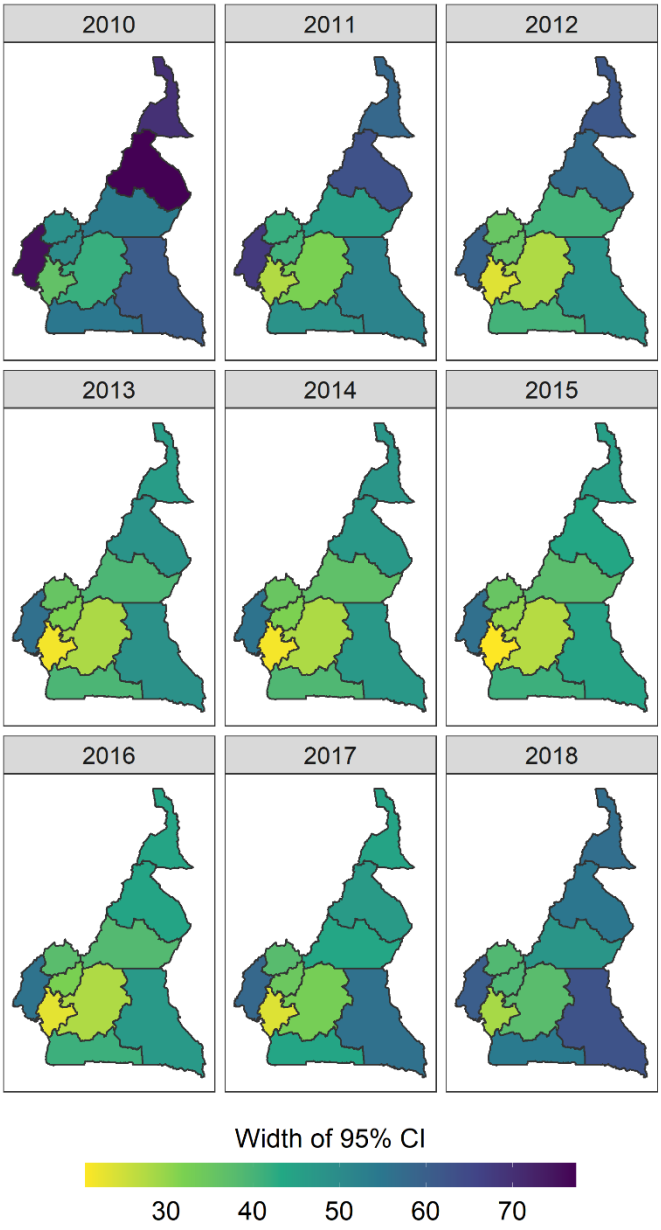


Figure C.7 Cameroon Admin 1 U5MR estimates by year with associated 95% credible intervals for 2010-2018

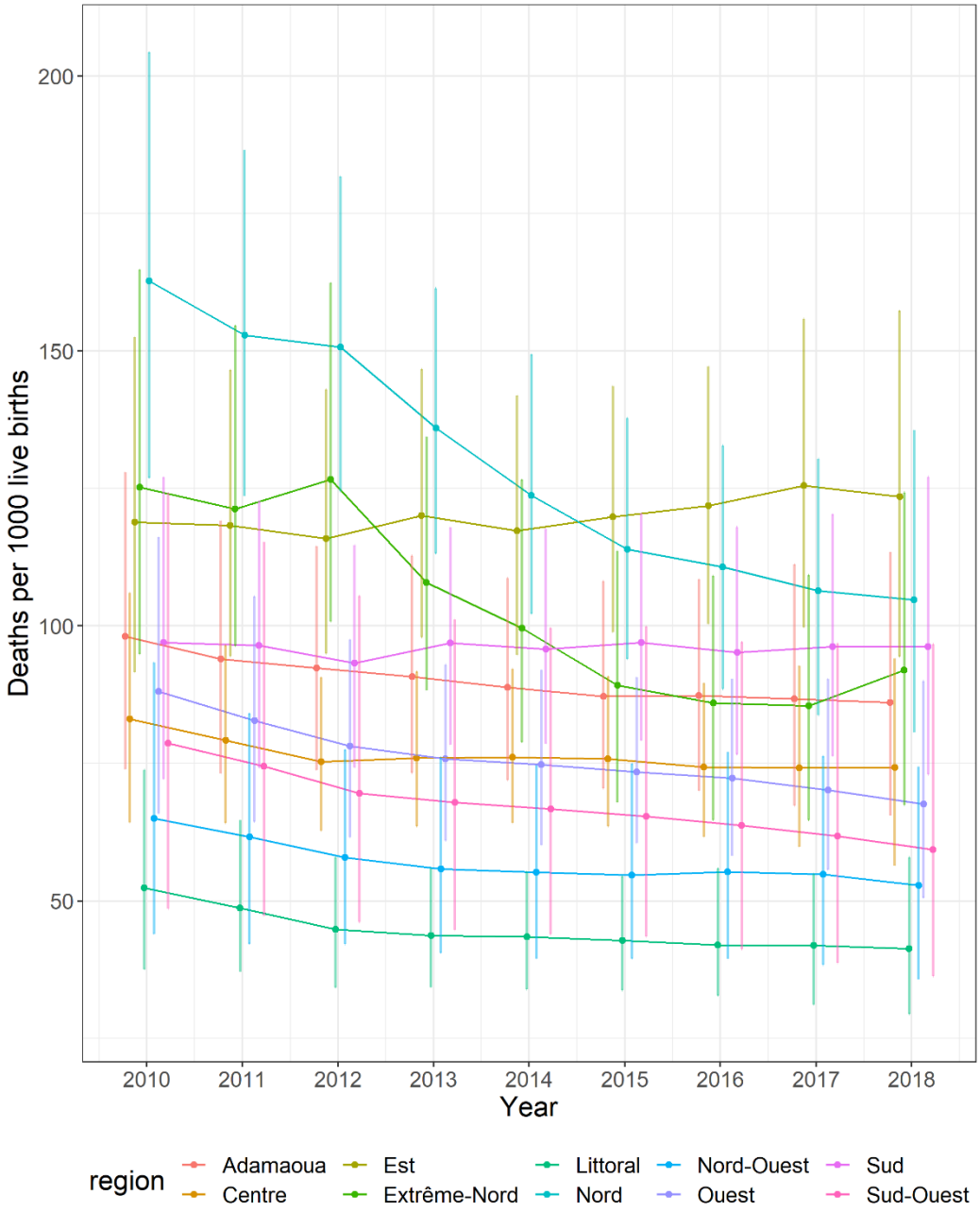


Figure C.8 Cameroon Admin 2 U5MR estimates for 2010-2018

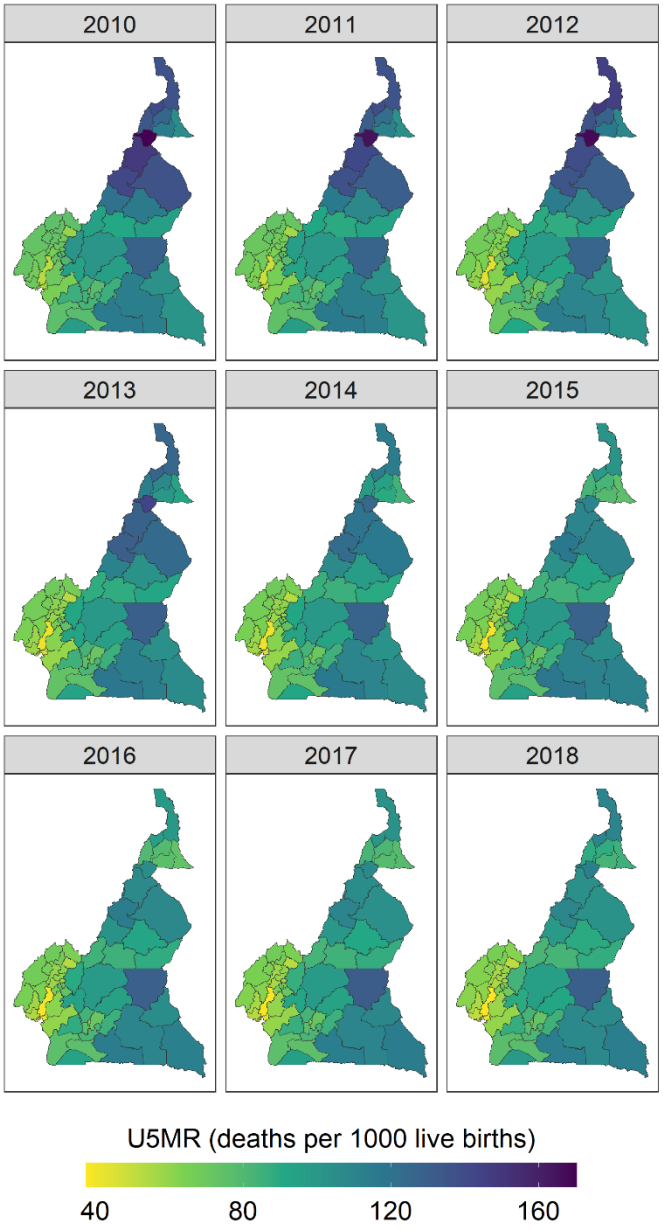


Figure C.9 Cameroon Admin 2 U5MR 95% credible interval width for 2010-2018

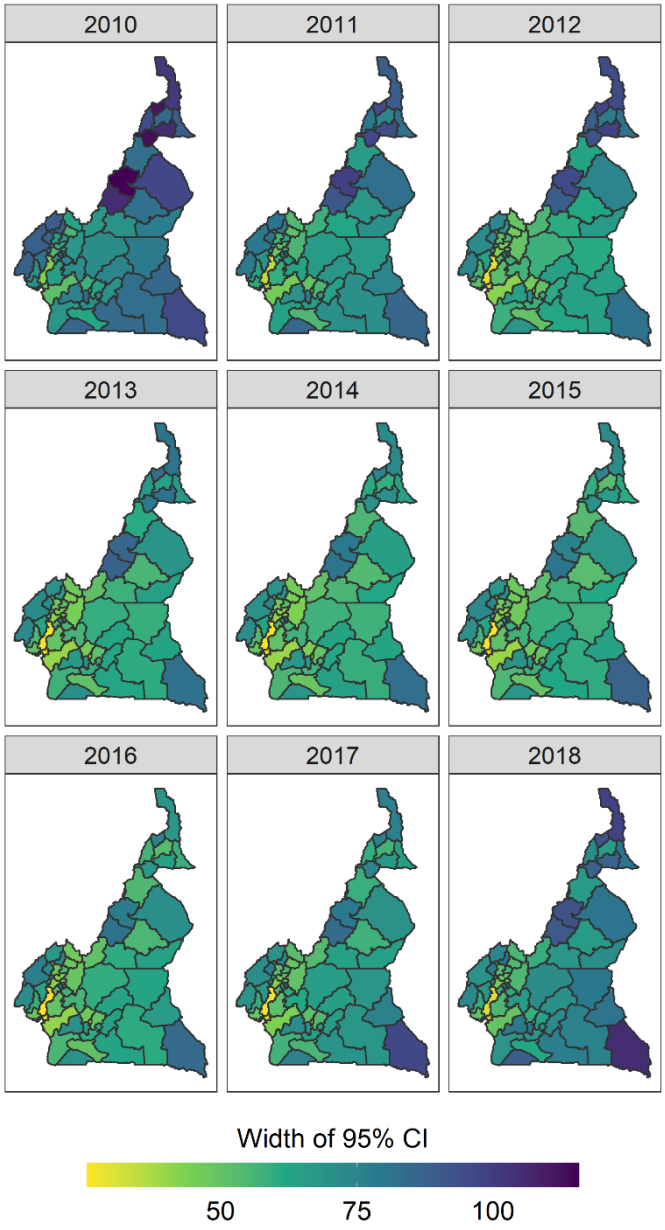


Figure C.10 Cameroon Admin 2 U5MR estimates by year for 2010-2018

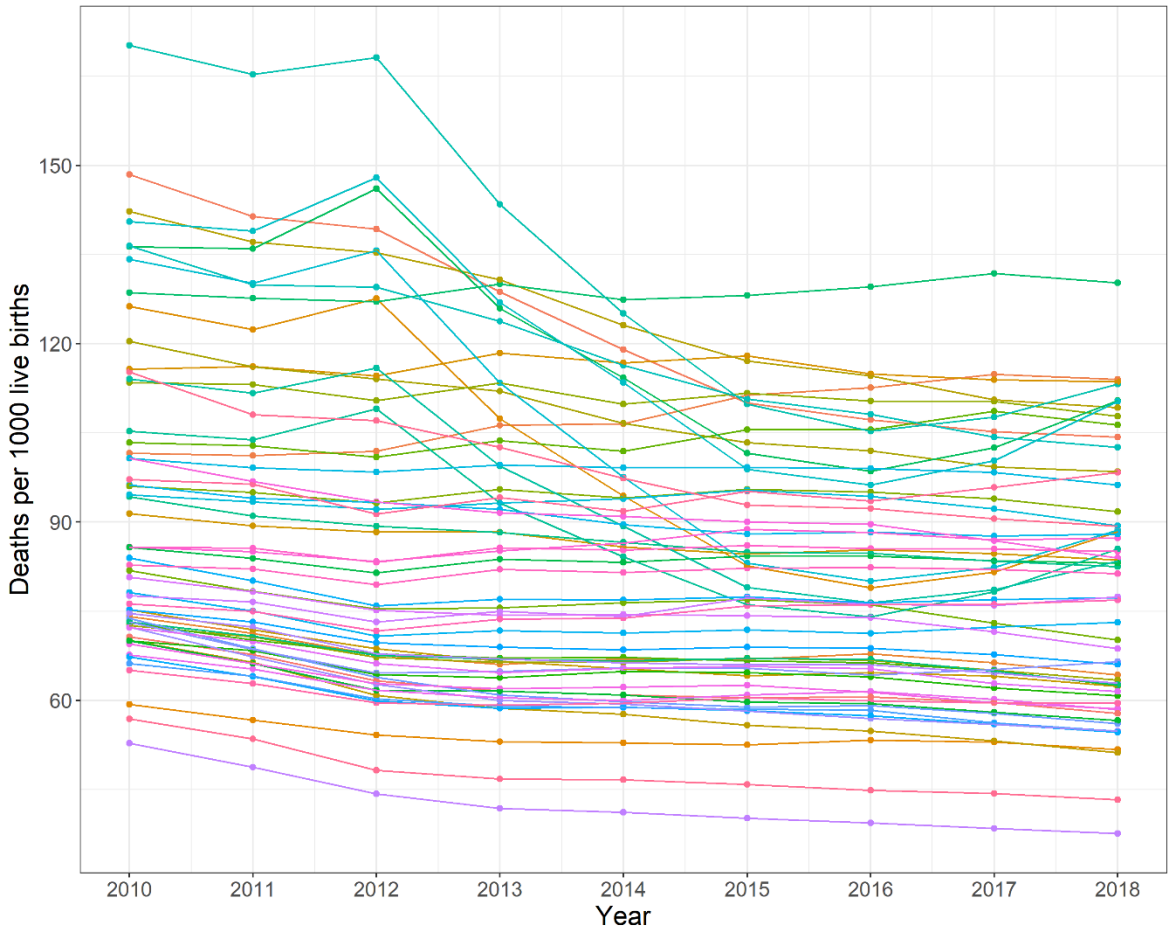


Figure C.11 **Ridgeplot representation of posterior distribution of Admin 2 U5MR for Cameroon in 2018. On the top we show the regions with the lowest posterior median U5MR, and on the bottom those with the highest U5MR.**

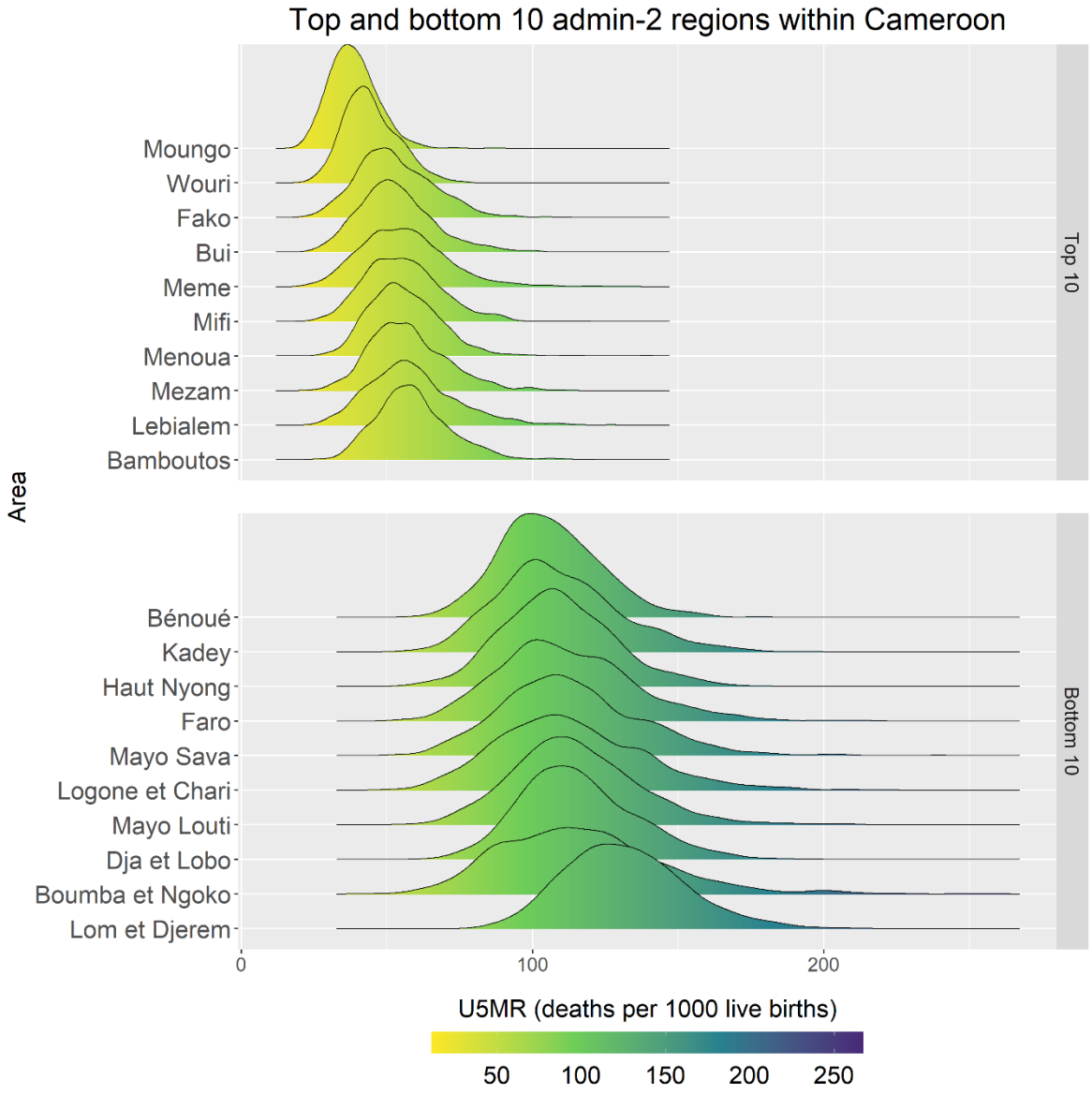
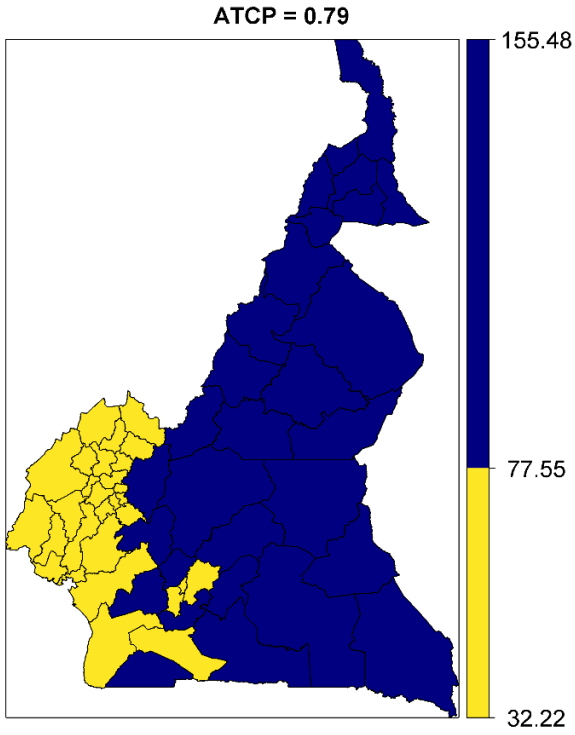
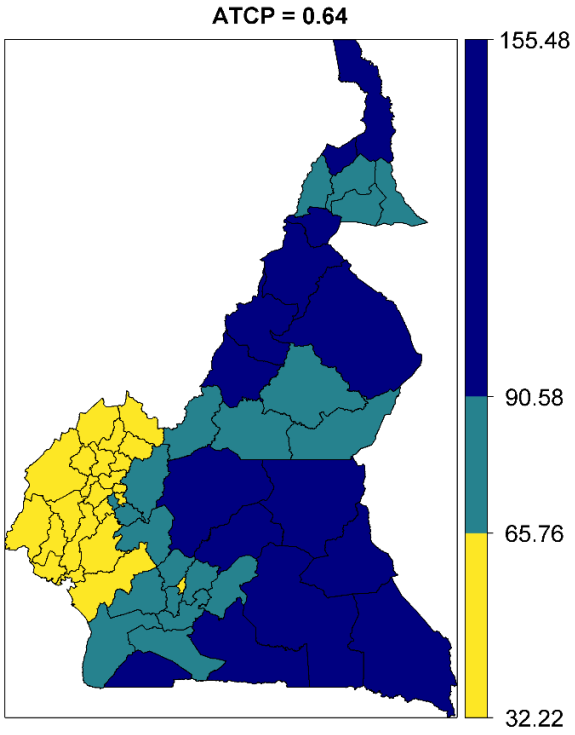


Figure C.12 Estimated Admin 2 U5MR ranking for Cameroon in 2018. On the left we show the regions with the highest U5MR, and on the right those with the lowest U5MR. The expected ranking (ER) of each area is also given.

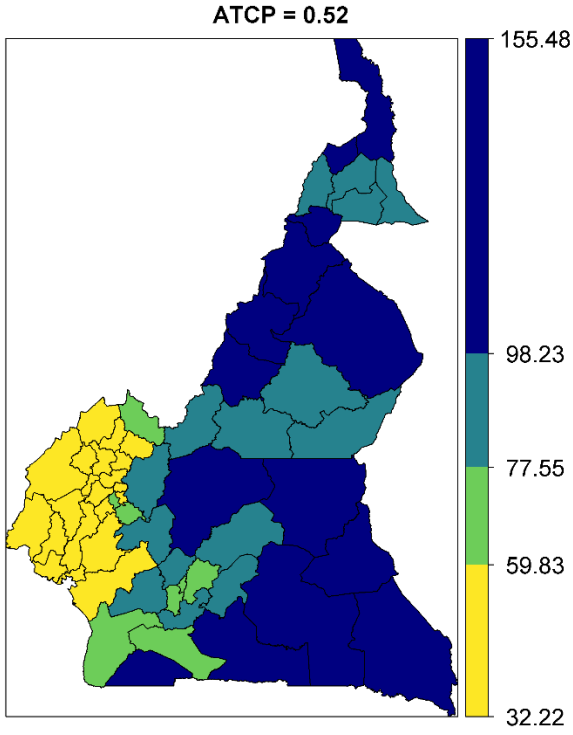
Figure C.13 Average True Classification Probabilities (ATCP) for K = 2, 3, 4 for Cameroon in 2018, where K is the number of colors on maps



(a) $K = 2$



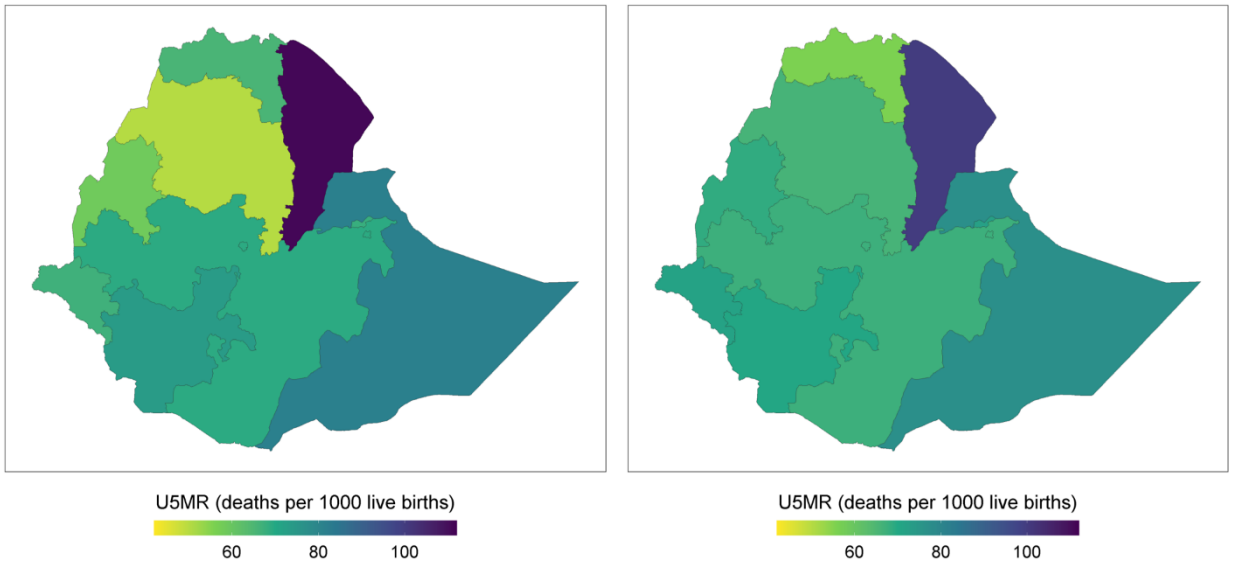
(b) $K = 3$



(c) $K = 4$

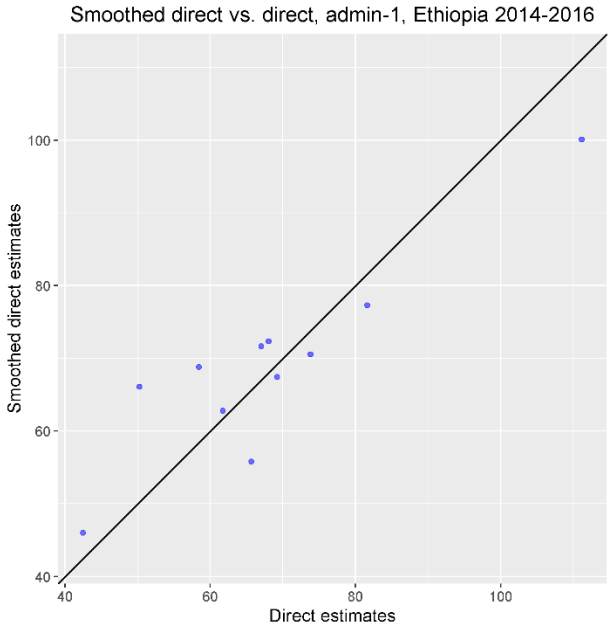
APPENDIX D DETAILED RESULTS FOR ETHIOPIA

Figure D.1 Comparison of Admin 1 direct and smoothed direct estimates for Ethiopia 2014-2016



(a) Direct estimates

(b) Smoothed direct estimates



(c) Direct versus smoothed direct estimates

Figure D.2 Aggregated yearly beta-binomial national estimates versus yearly direct national estimates, over time, and with 95% error bands. The aggregation is from Admin 2 to national.

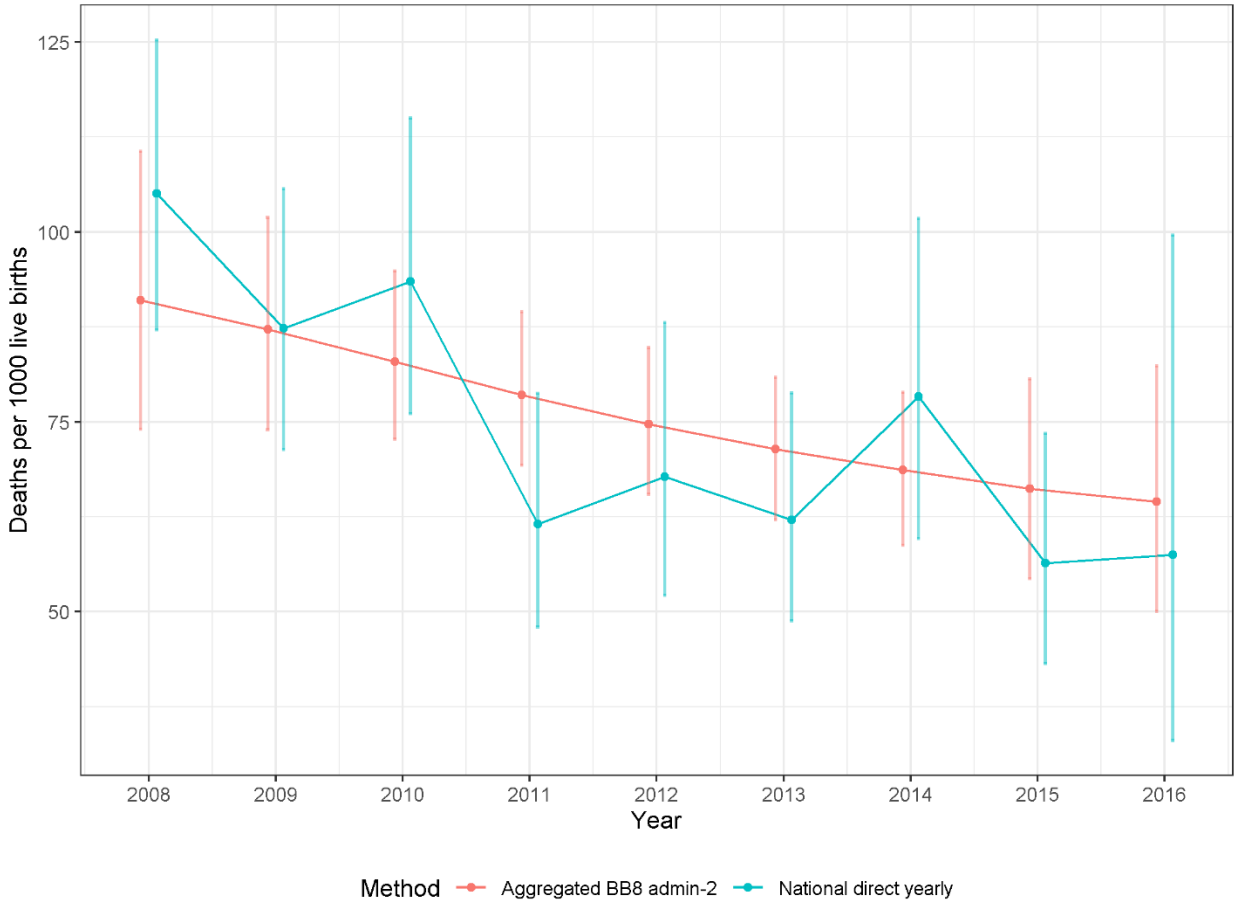


Figure D.3 **Probability for Admin 2 U5MR estimates exceeding national direct estimates for Ethiopia 2016. National rate over the period 2014-2016 (and its associated 95% CI) is 66.4 (54.3, 80.9) per 1,000 live births.**

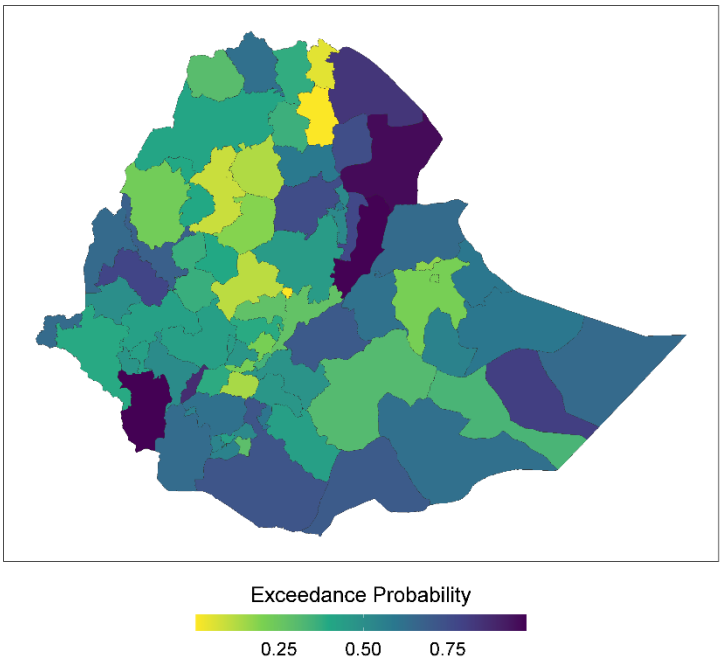


Figure D.4 **Odds ratios (urban/rural) over time for the age bands 0-1 months, 1-12 months, >12 months**

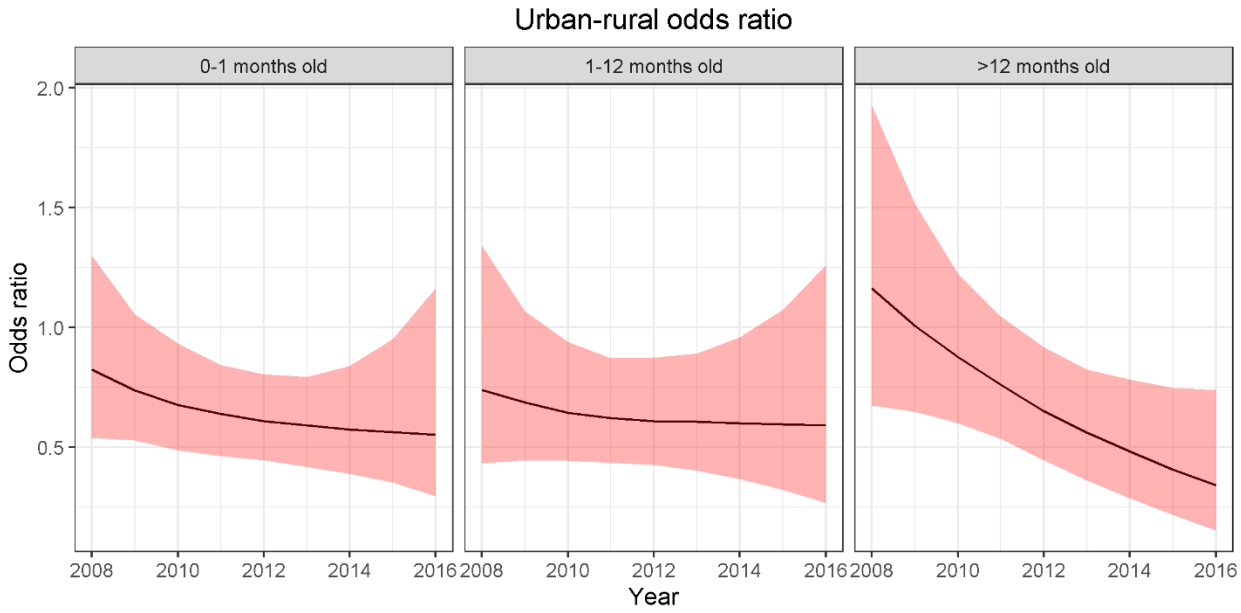


Figure D.5 Ethiopia Admin 1 U5MR estimates for 2008-2016

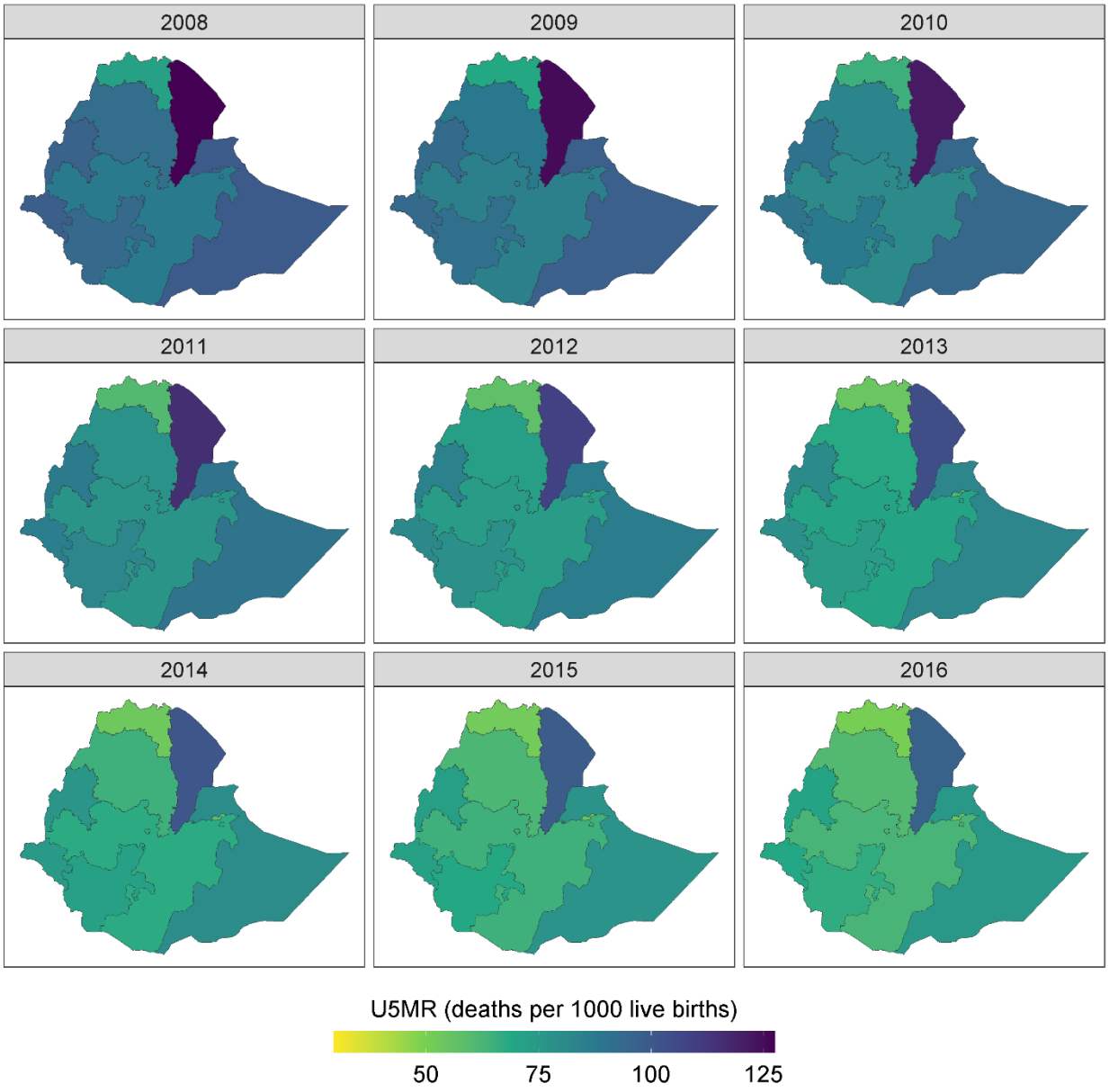


Figure D.6 Ethiopia Admin 1 U5MR 95% credible interval width for 2008-2016

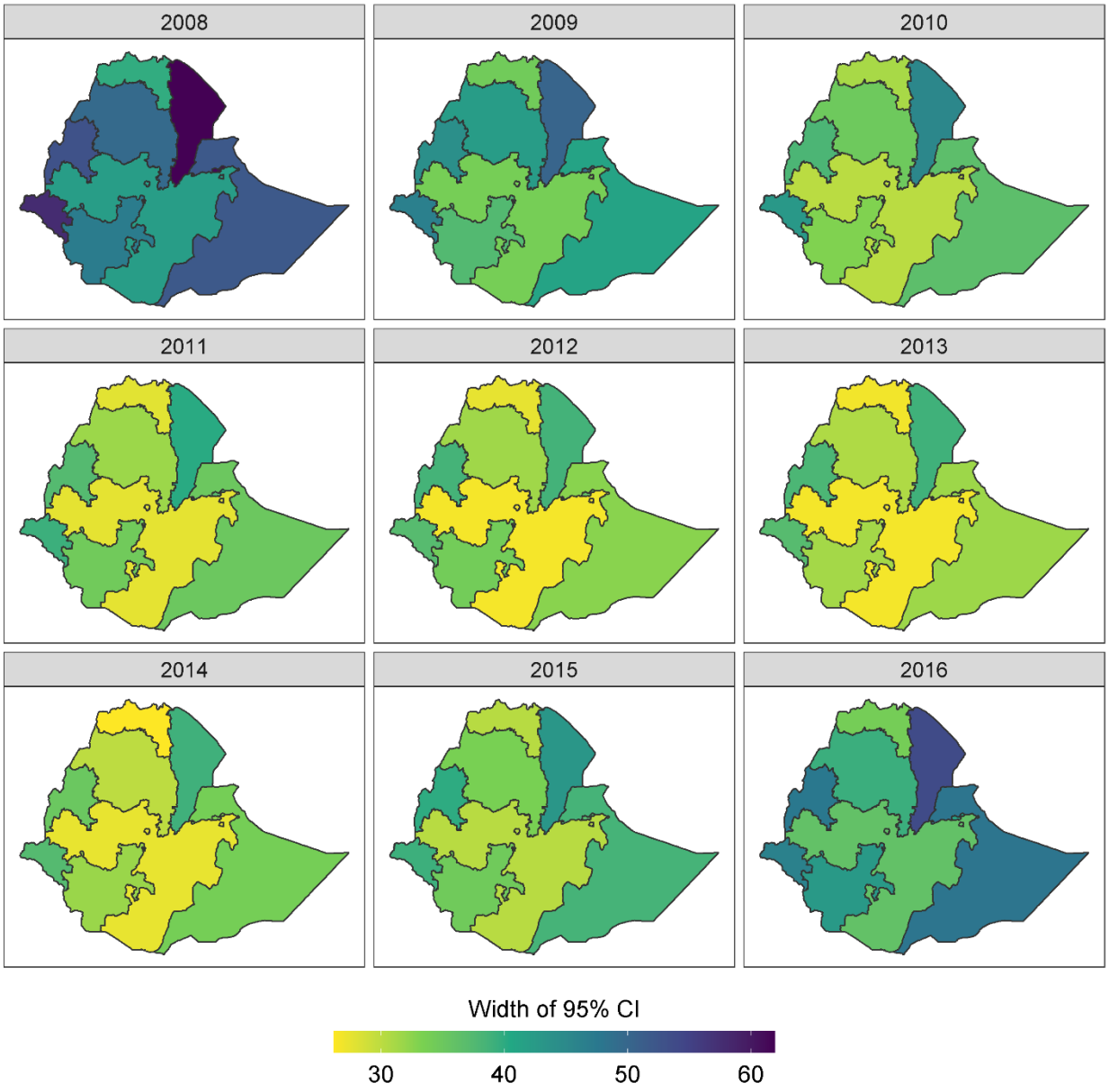


Figure D.7 Ethiopia Admin 1 U5MR estimates by year with associated 95% credible intervals for 2008-2016

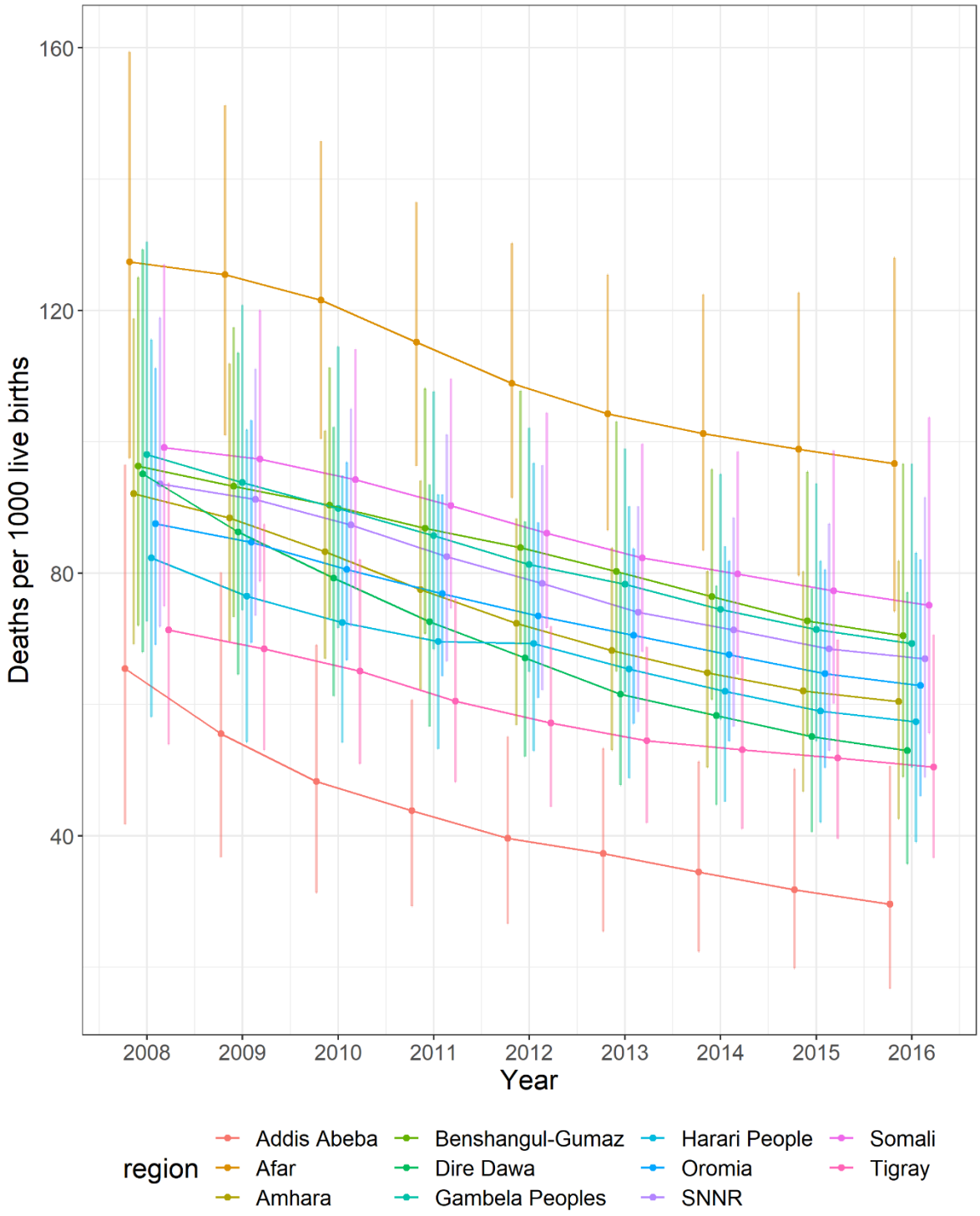


Figure D.8 Ethiopia Admin 2 U5MR estimates for 2008-2016

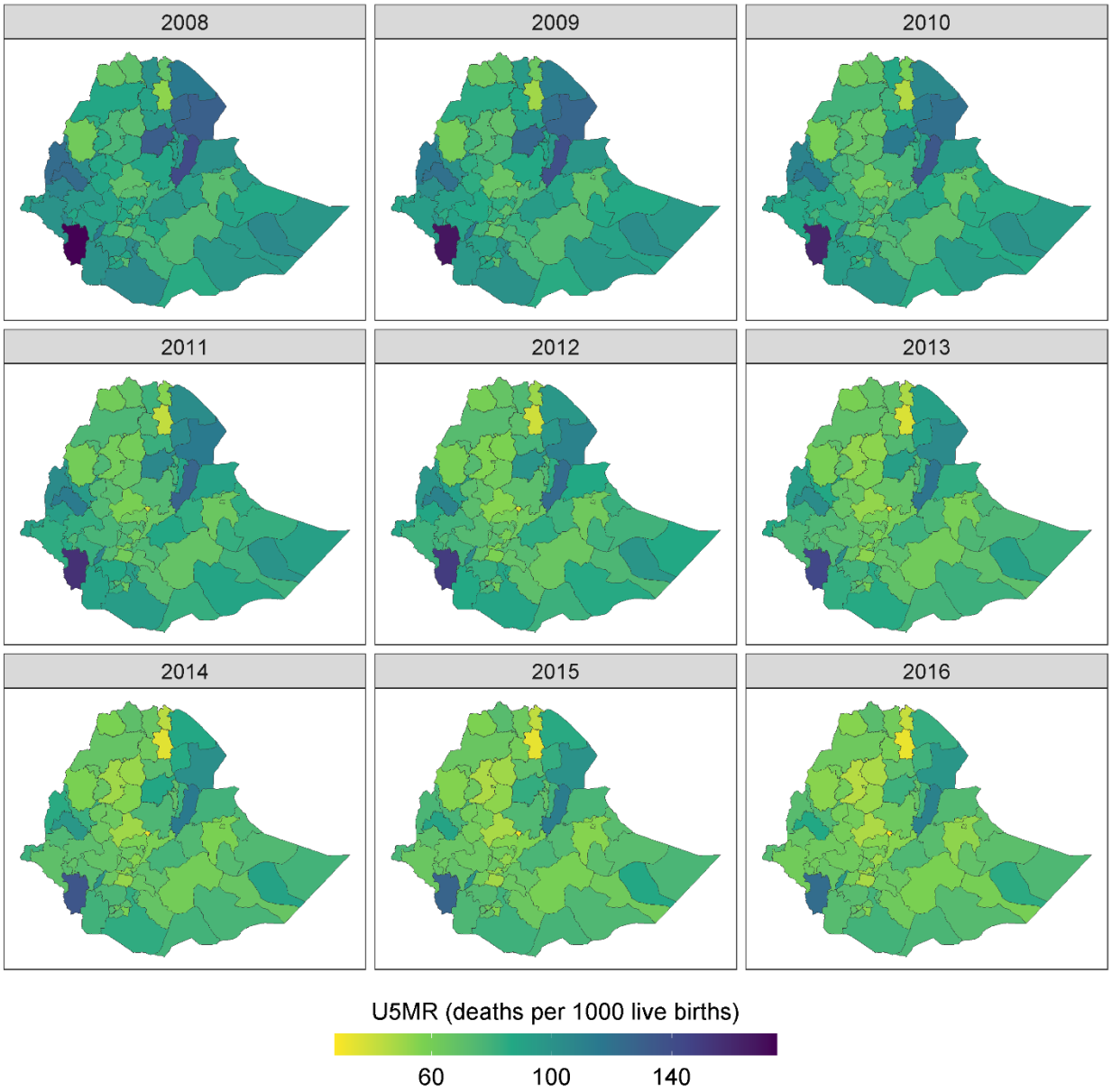


Figure D.9 Ethiopia Admin 2 U5MR 95% credible interval width for 2008-2016

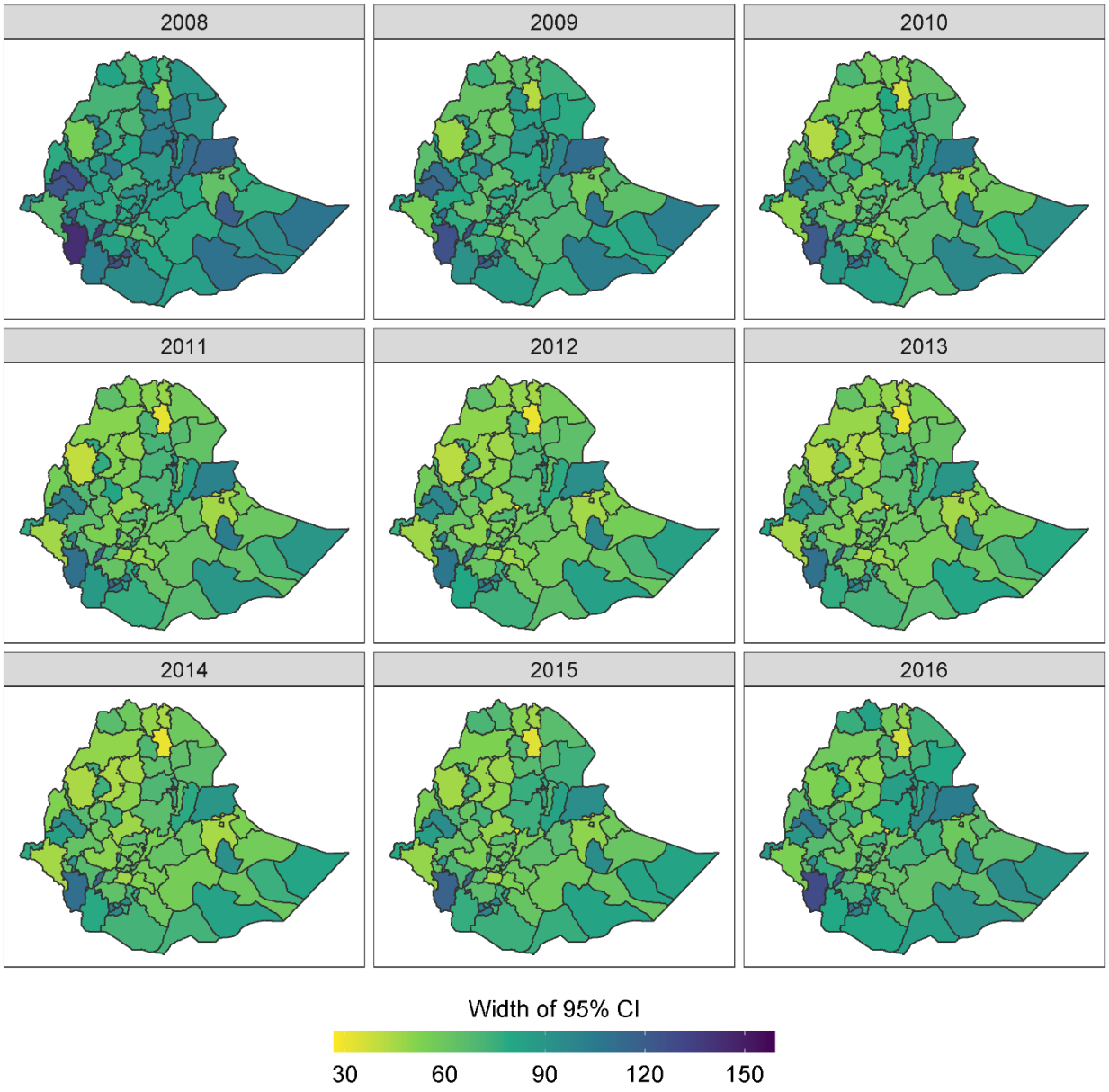


Figure D.10 Ethiopia Admin 2 U5MR estimates by year for 2008-2016

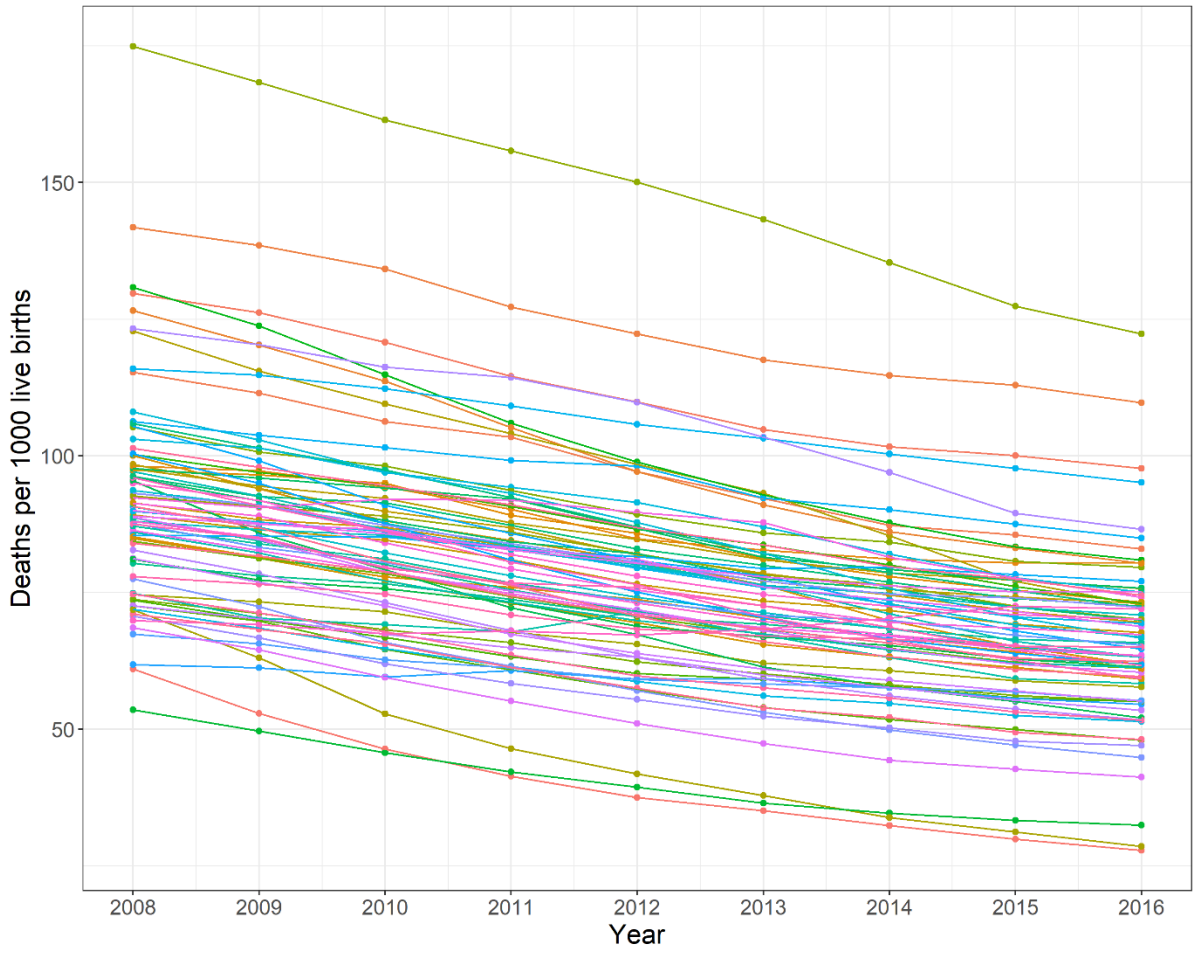


Figure D.11 Ridgeplot representation of posterior distribution of Admin 2 U5MR for Ethiopia in 2016. On the top we show the regions with the lowest posterior median U5MR, and on the bottom those with the highest U5MR.

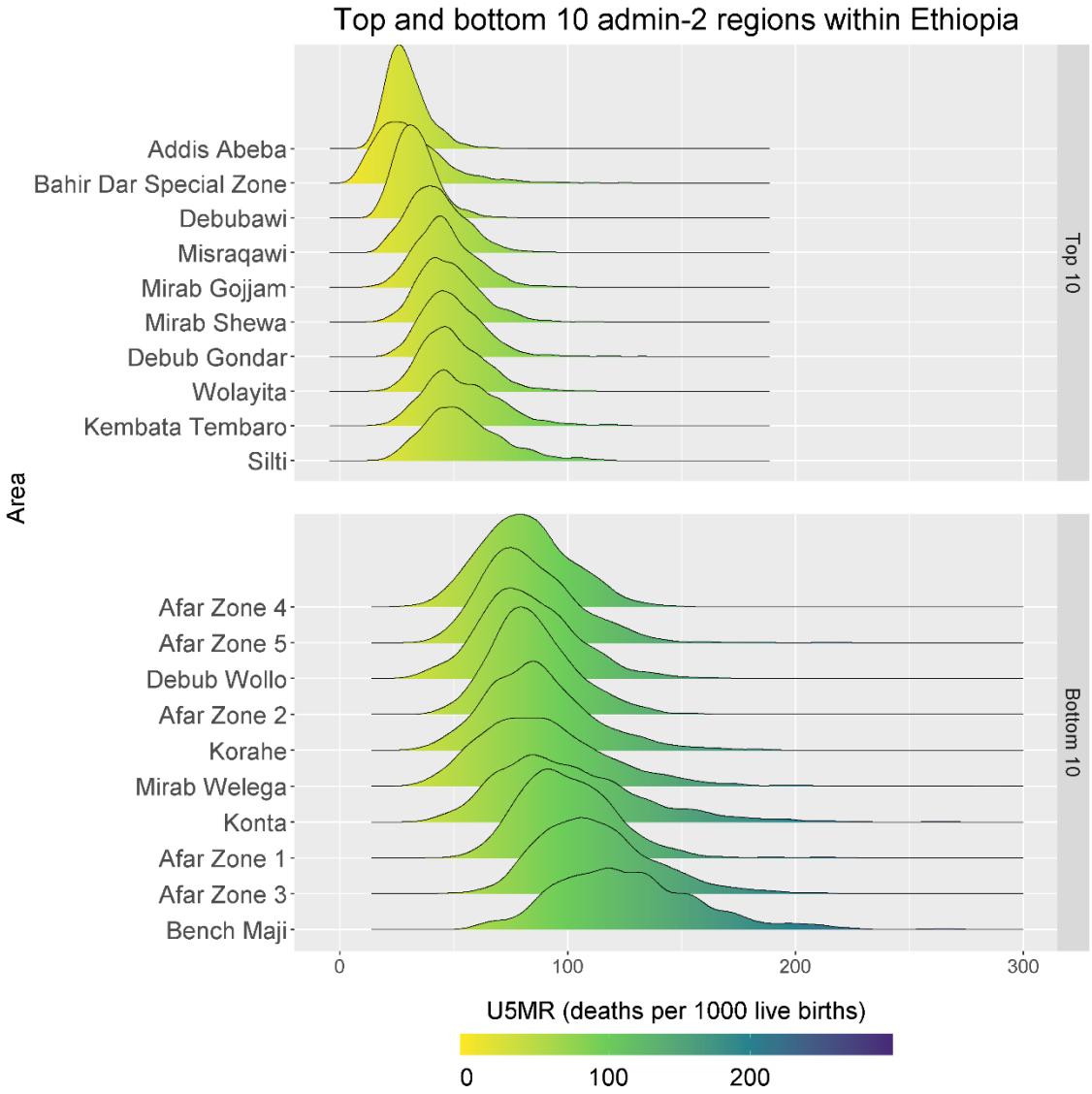


Figure D.12 Estimated Admin 2 U5MR ranking for Ethiopia in 2016. On the left we show the regions with the highest U5MR, and on the right those with the lowest U5MR. The expected ranking (ER) of each area is also given.

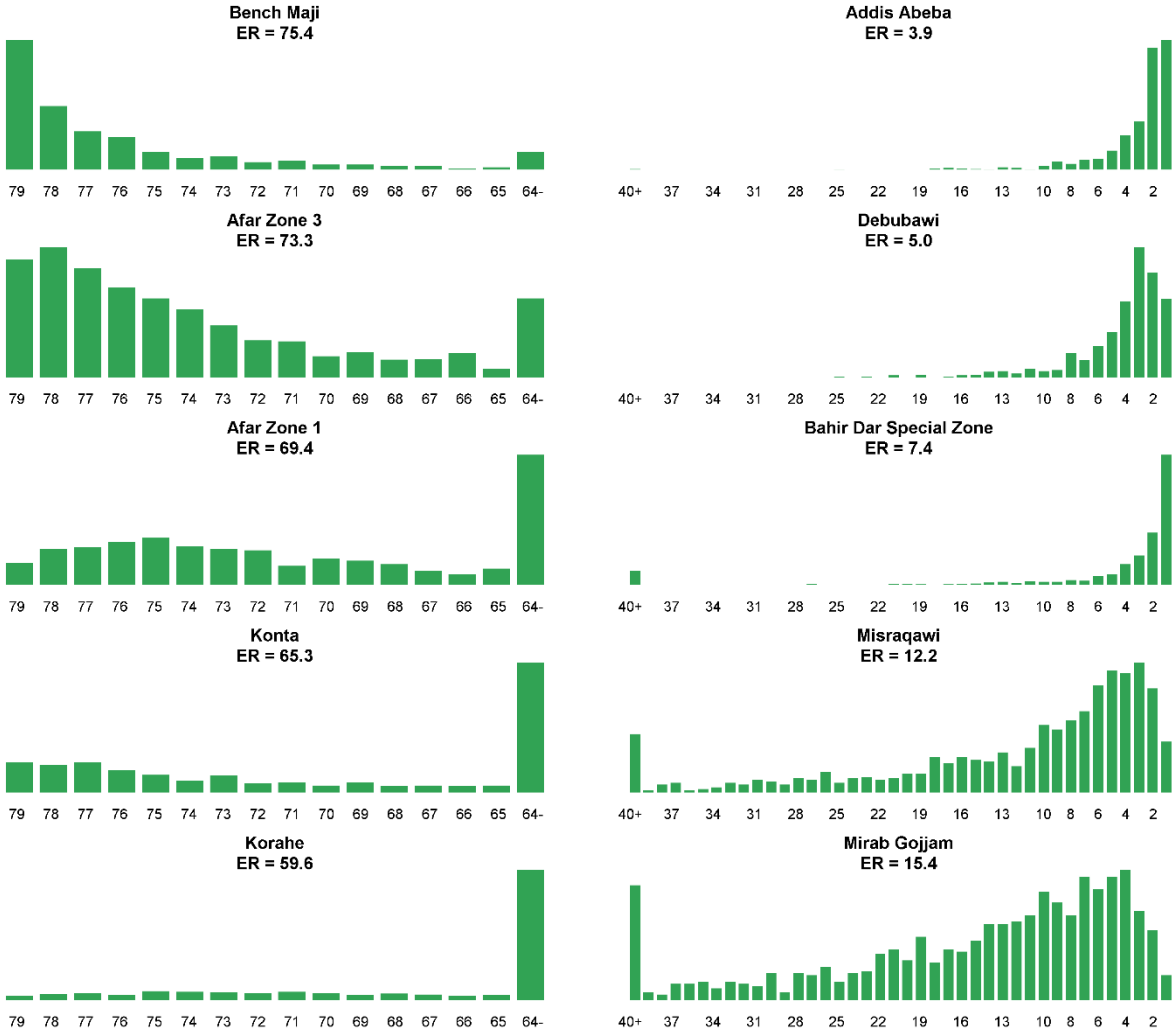
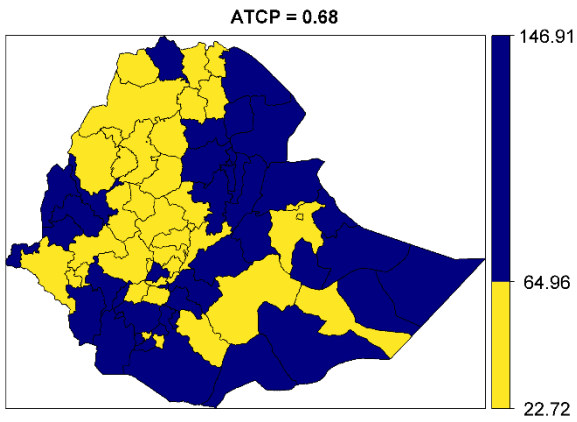
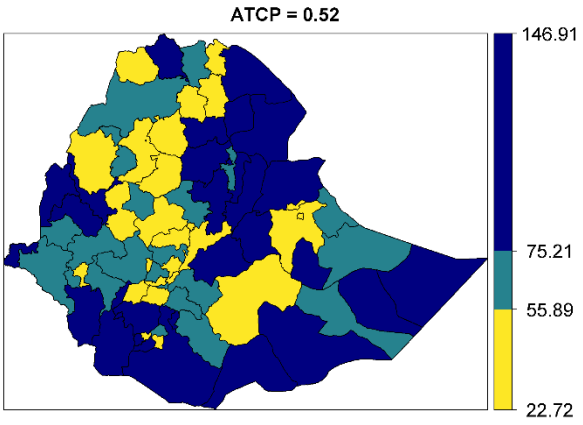


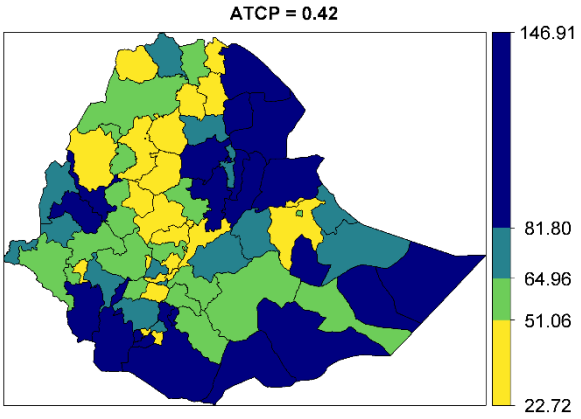
Figure D.13 Average True Classification Probabilities (ATCP) for K = 2, 3, 4 for Ethiopia in 2016, where K is the number of colors on maps



(a) $K = 2$



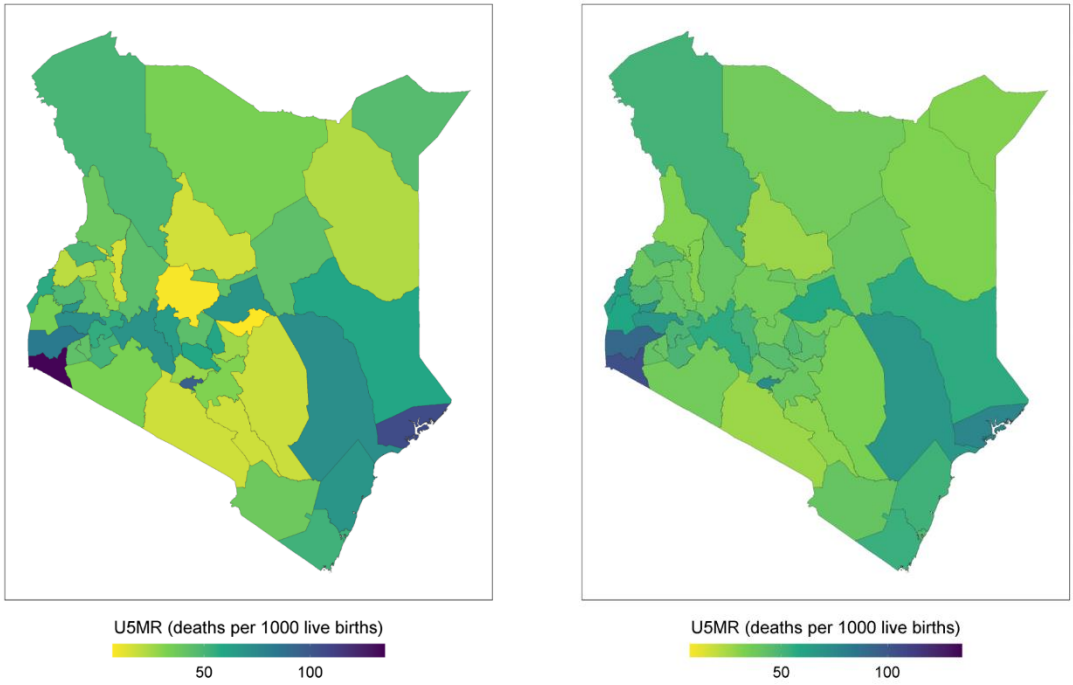
(b) $K = 3$



(c) $K = 4$

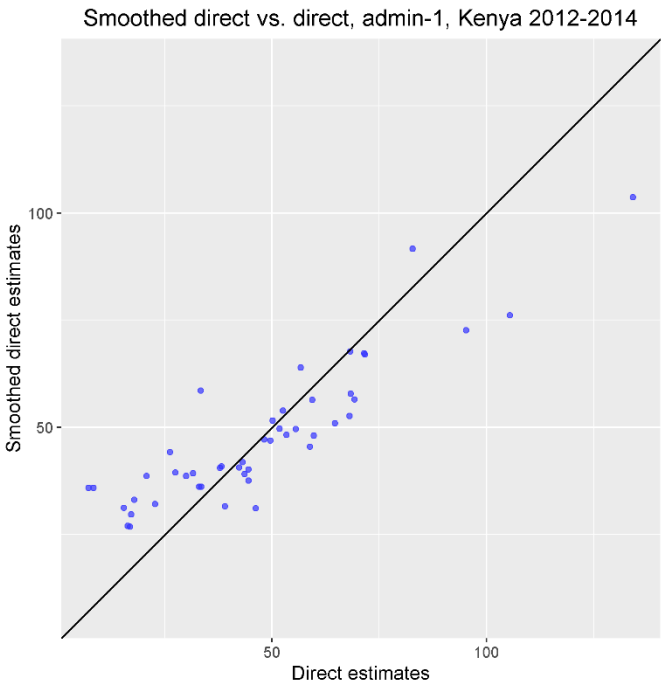
APPENDIX E DETAILED RESULTS FOR KENYA

Figure E.1 Comparison of Admin 1 direct and smoothed direct estimates for Kenya 2012-2014



(a) Direct estimates

(b) Smoothed direct estimates



(c) Direct versus smoothed direct estimates

Figure E.2 **Aggregated yearly beta-binomial national estimates versus yearly direct national estimates, over time, and with 95% error bands. The aggregation is from Admin 2 to national.**

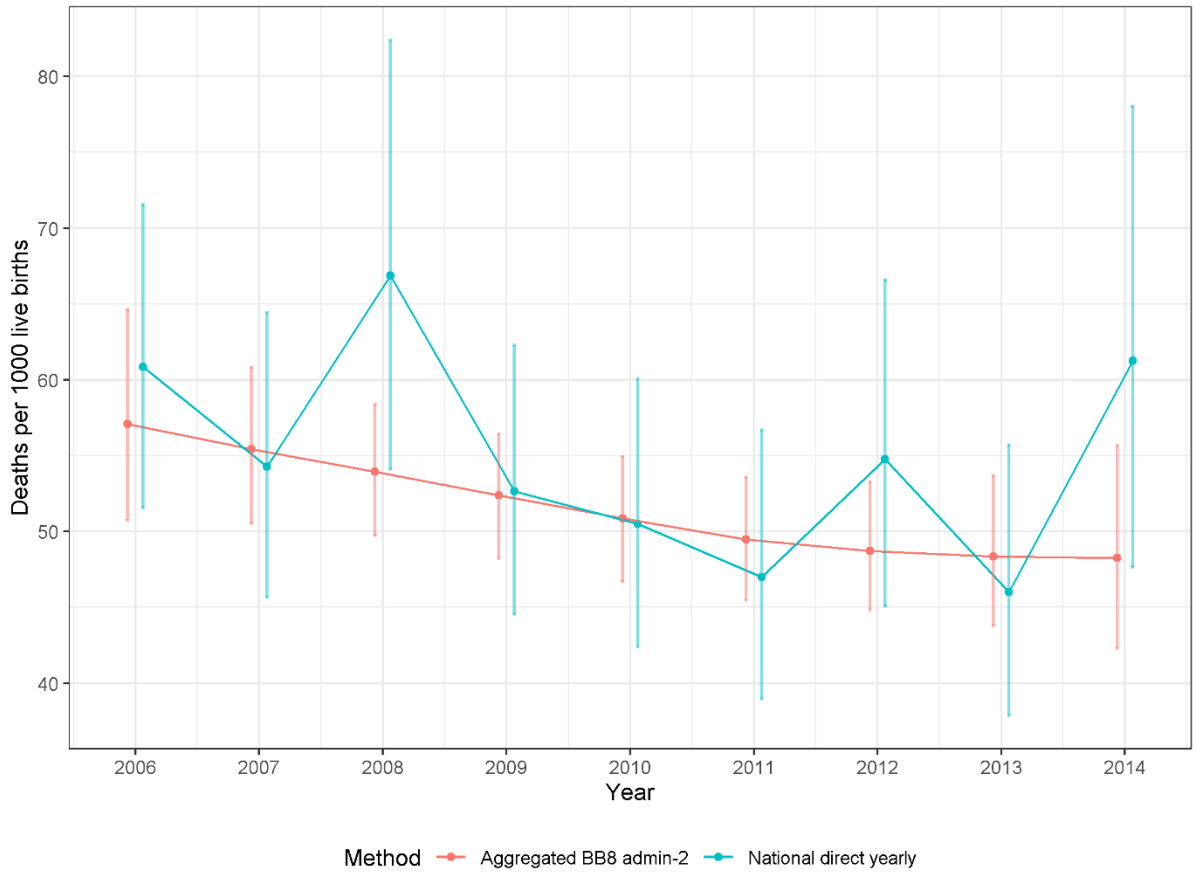


Figure E.3 **Probability for Admin 2 U5MR estimates exceeding national direct estimates for Kenya 2014. National rate over the period 2012-2014 (and its associated 95% CI) is 53.0 (47.0, 59.7) per 1,000 live births.**

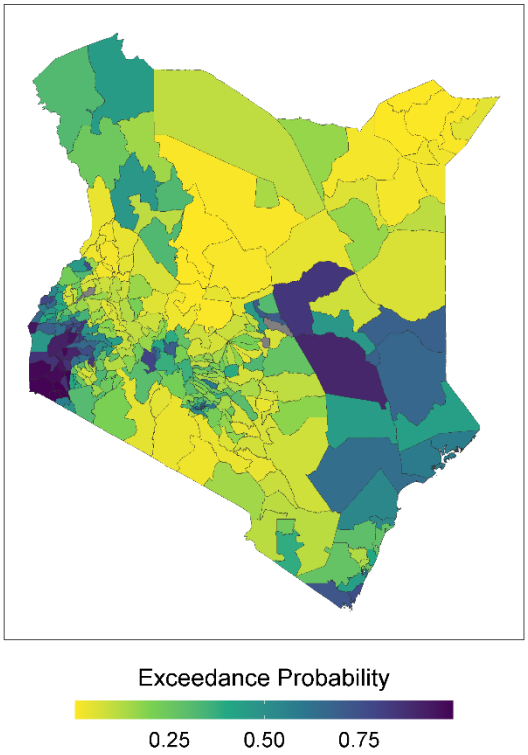


Figure E.4 **Odds ratios (urban/rural) over time for the age bands 0-1 months, 1-12 months, >12 months**

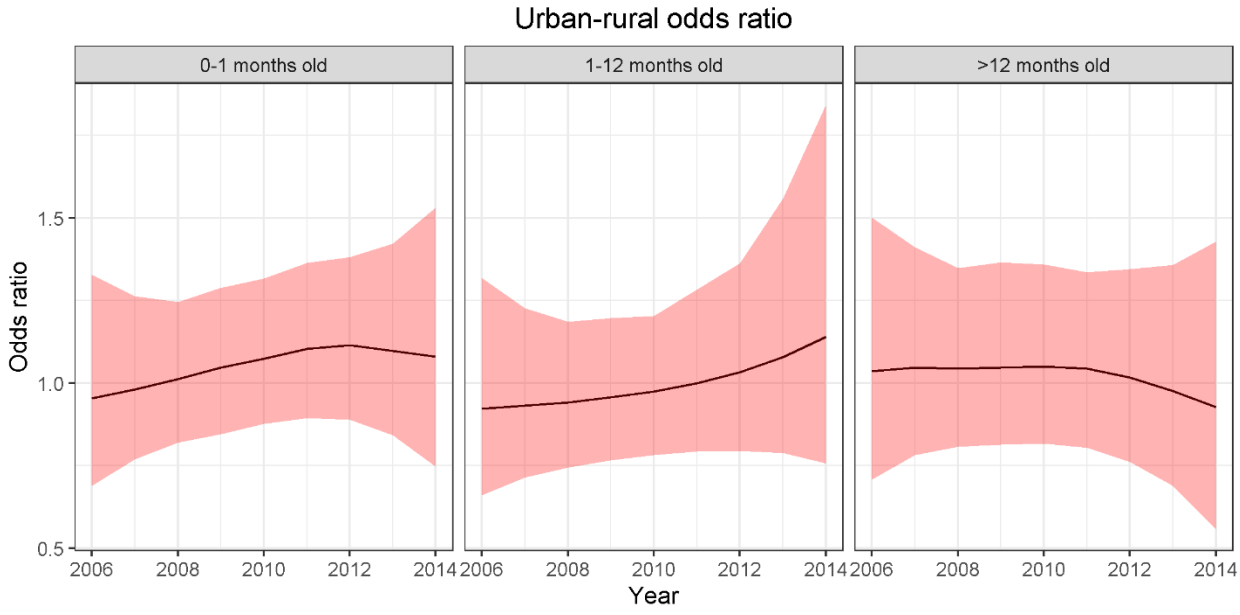


Figure E.5 Kenya Admin 1 U5MR estimates for 2006-2014

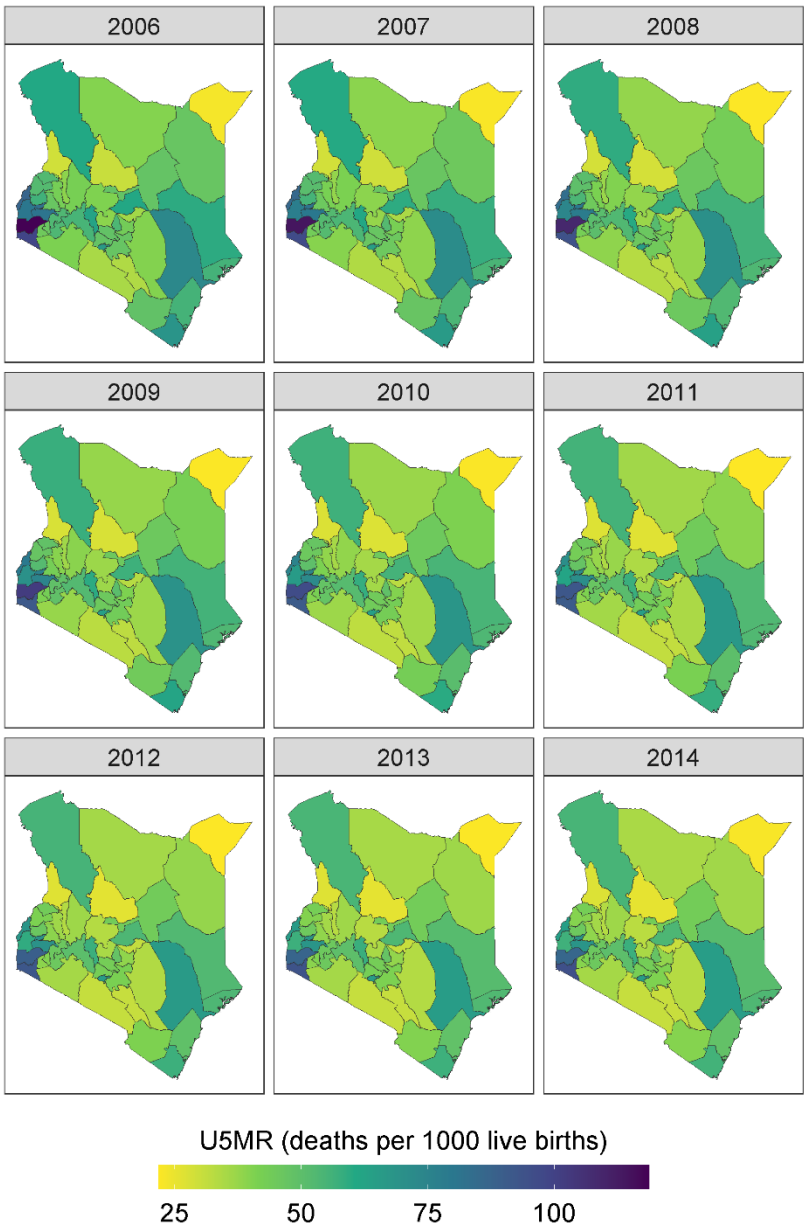


Figure E.6 Kenya Admin 1 U5MR 95% credible interval width for 2006-2014

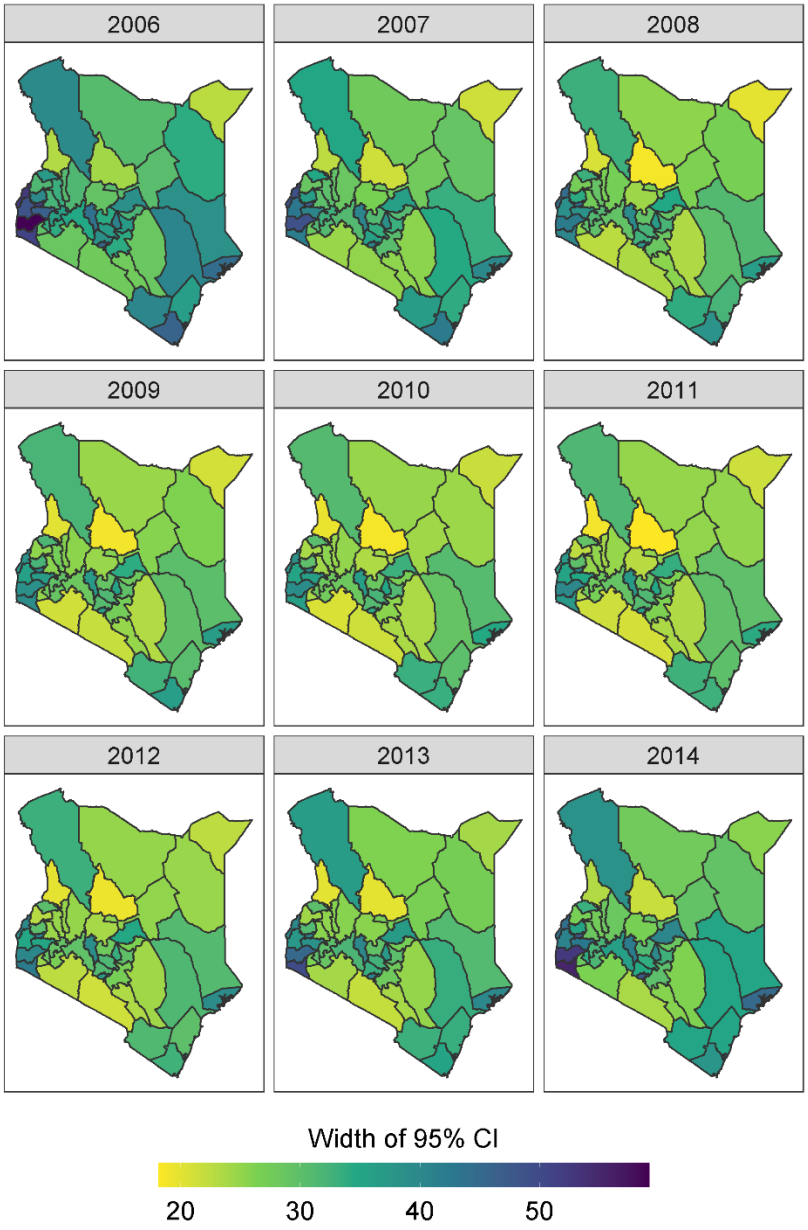


Figure E.7 Kenya Admin 1 U5MR estimates by year with associated 95% credible intervals for 2006-2014

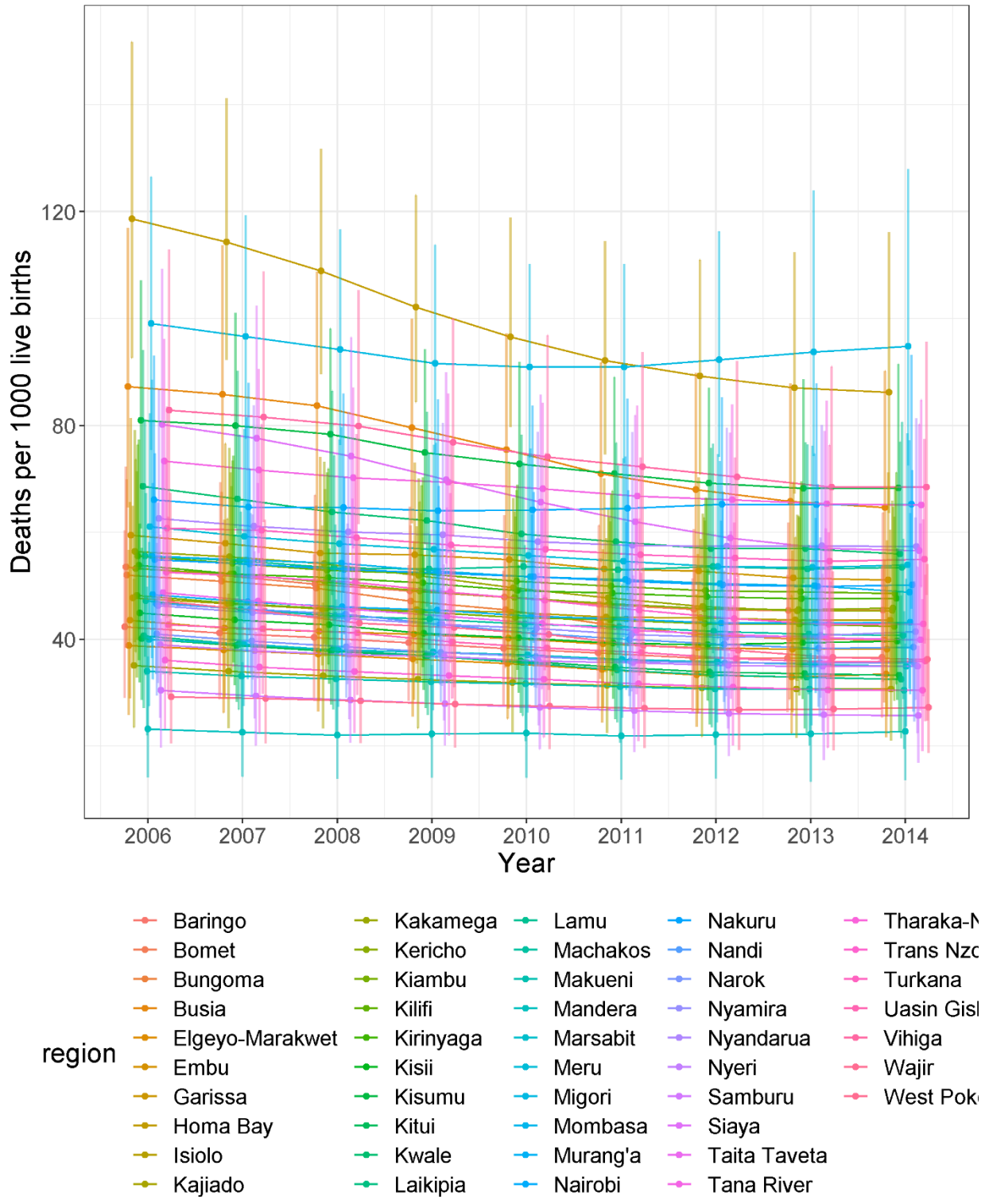


Figure E.8 Kenya Admin 2 U5MR estimates for 2006-2014

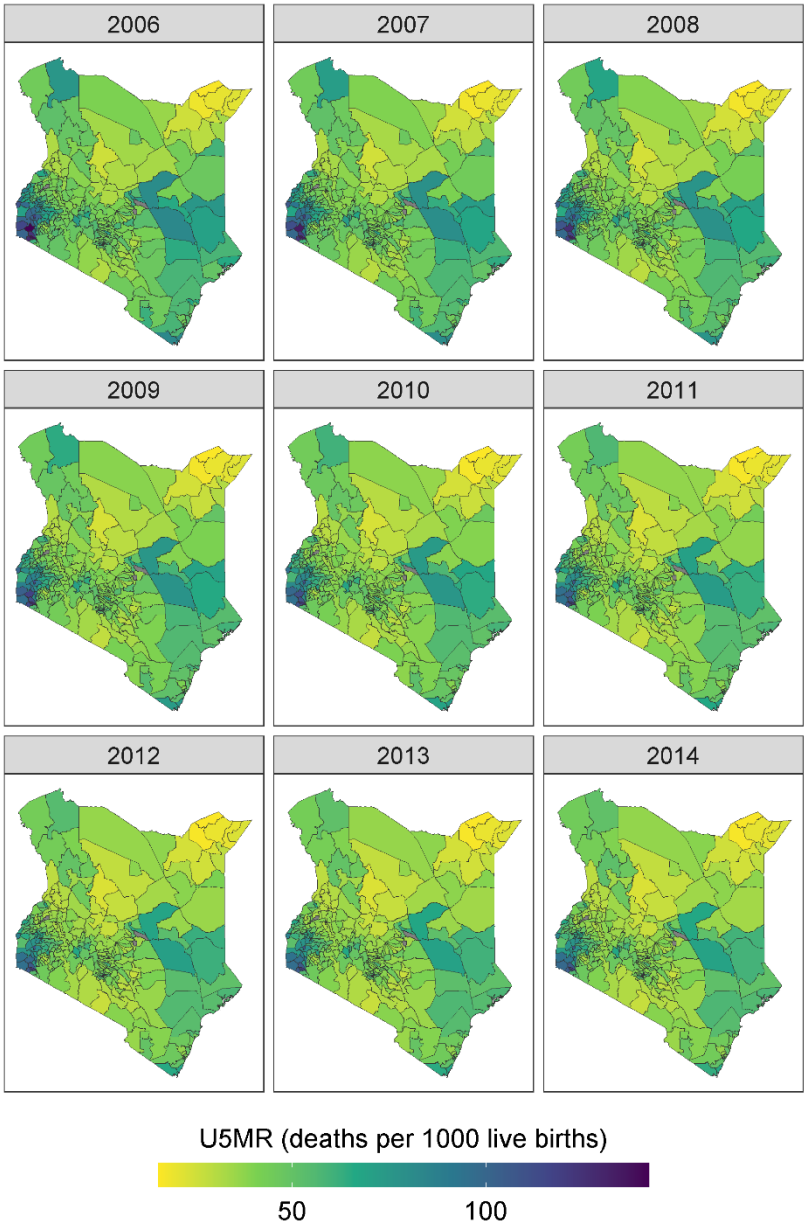


Figure E.9 Kenya Admin 2 U5MR 95% credible interval width for 2006-2014

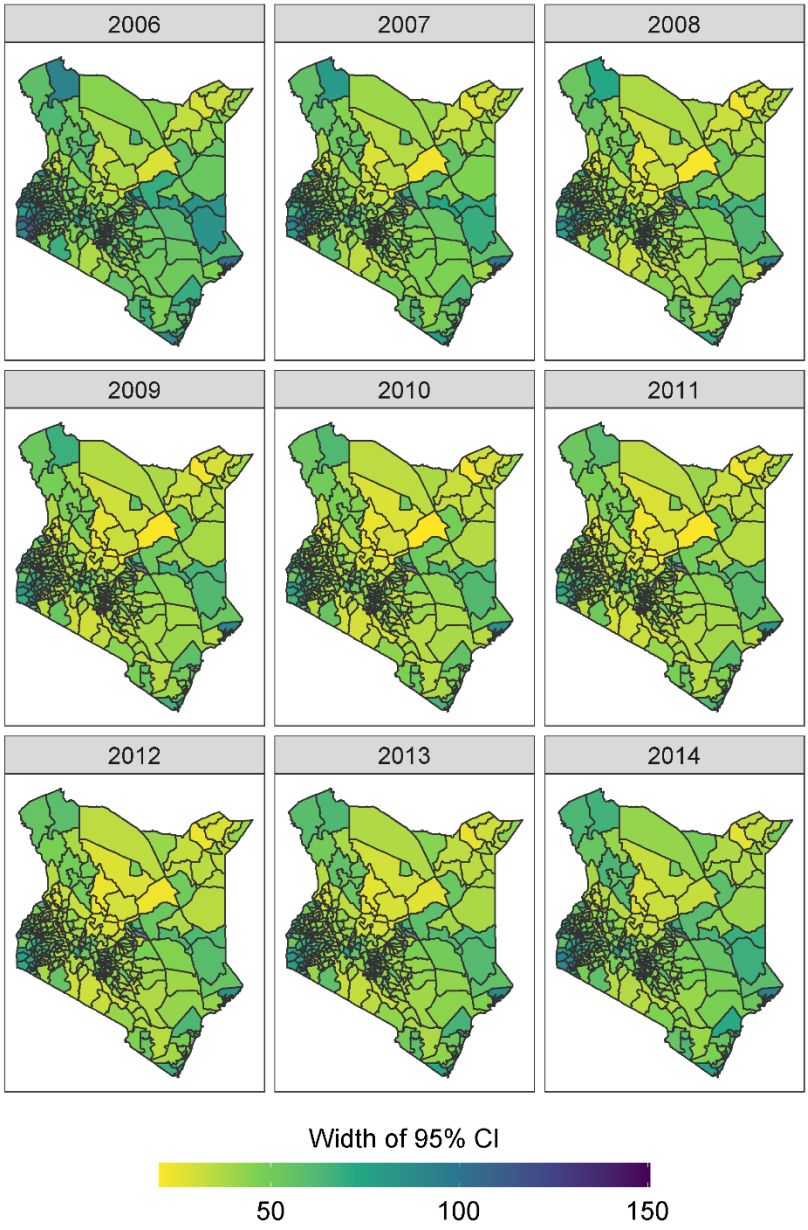


Figure E.10 Kenya Admin 2 U5MR estimates by year for 2006-2014

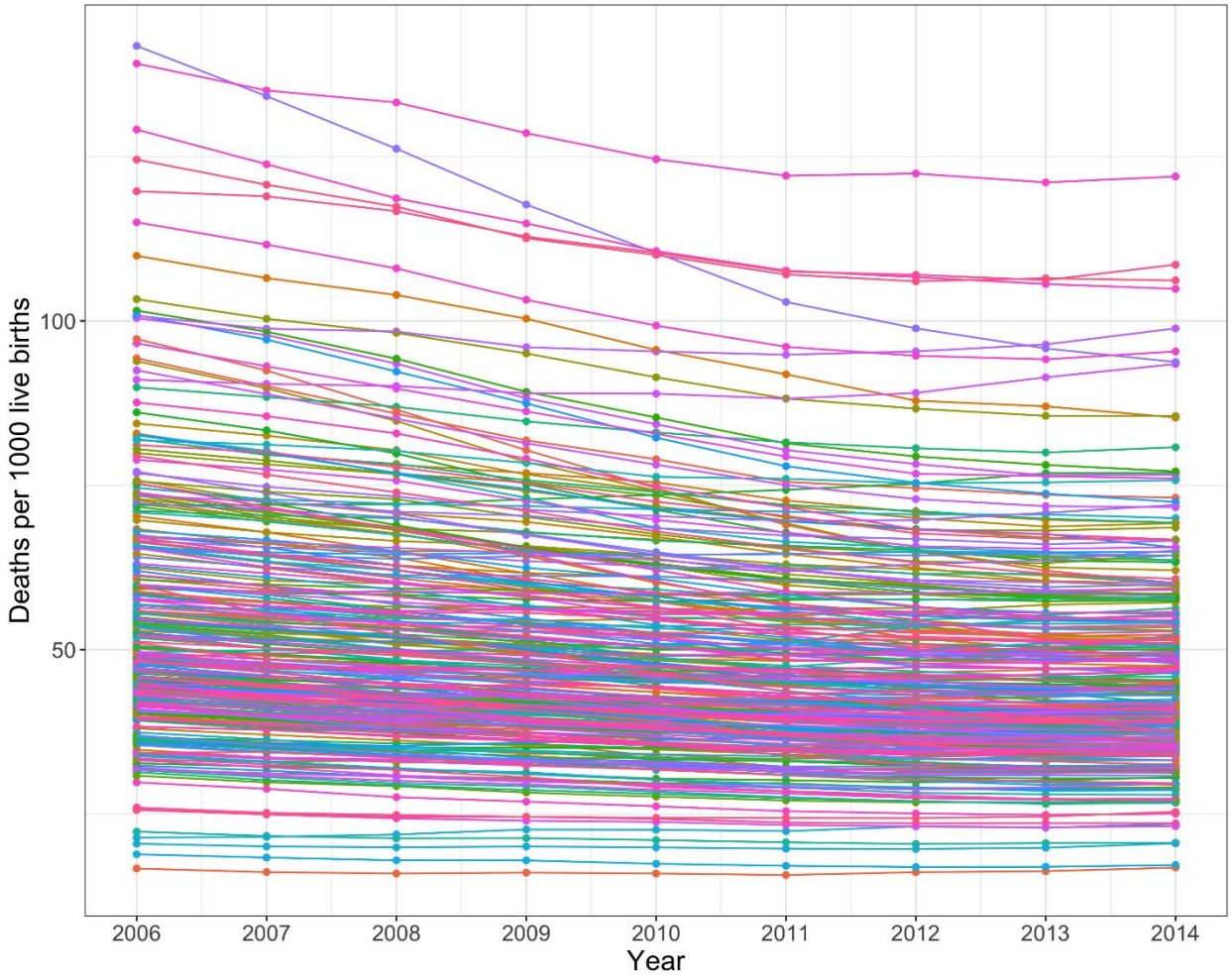


Figure E.11 **Ridgeplot representation of posterior distribution of Admin 2 U5MR for Kenya in 2014. On the top we show the regions with the lowest posterior median U5MR, and on the bottom those with the highest U5MR.**

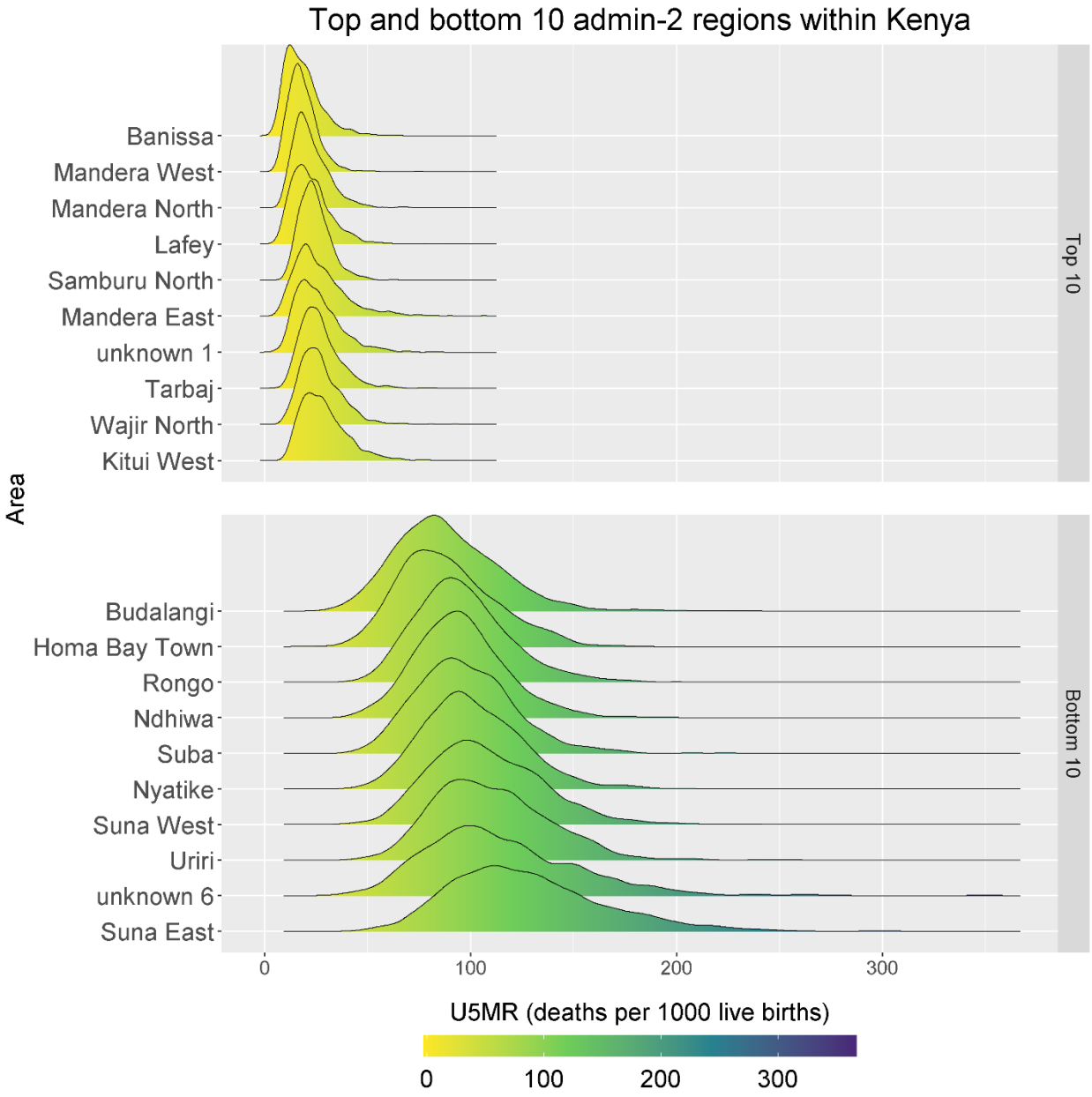


Figure E.12 Estimated Admin 2 U5MR ranking for Kenya in 2014. On the left we show the regions with the highest U5MR, and on the right those with the lowest U5MR. The expected ranking (ER) of each area is also given.

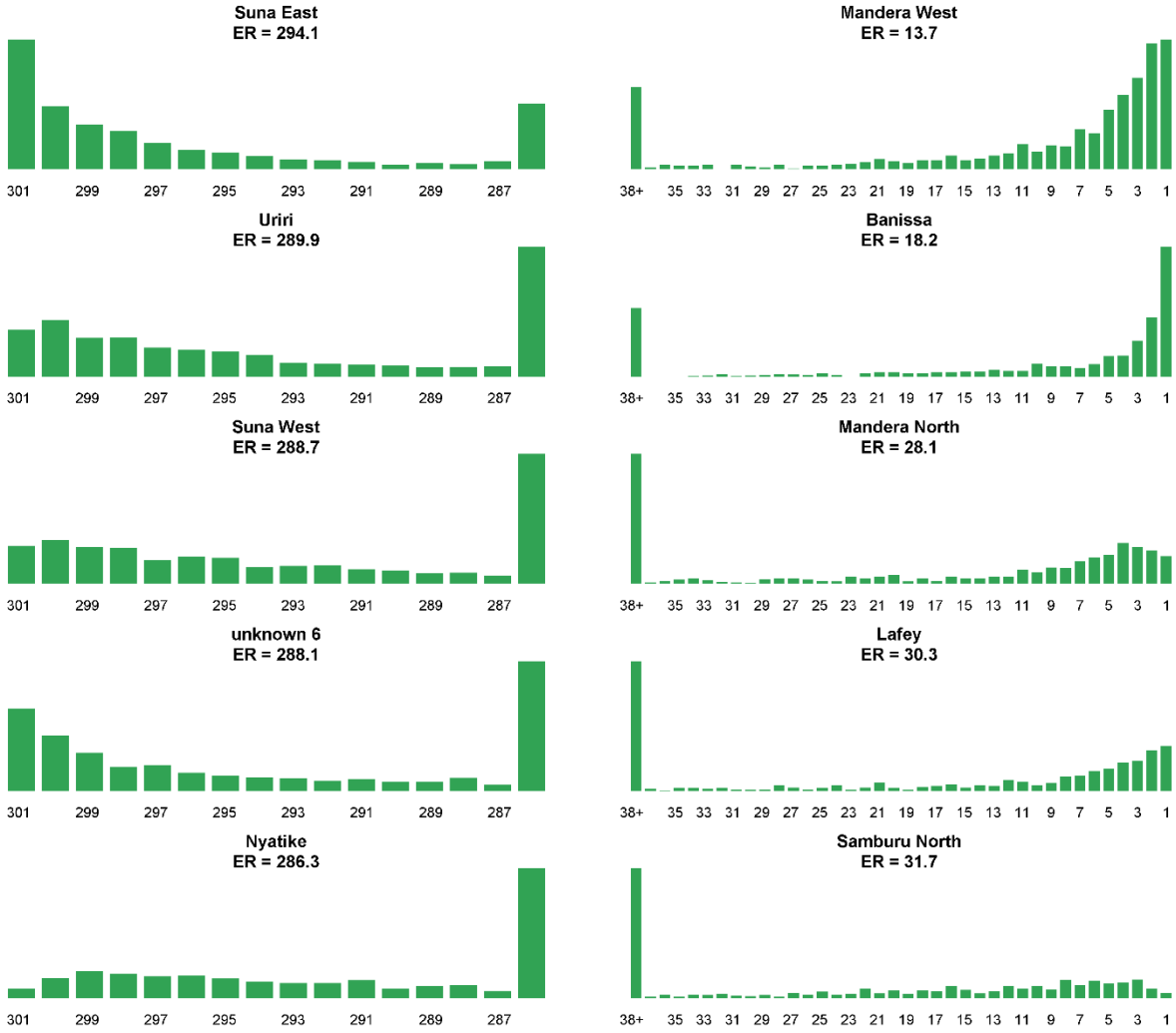
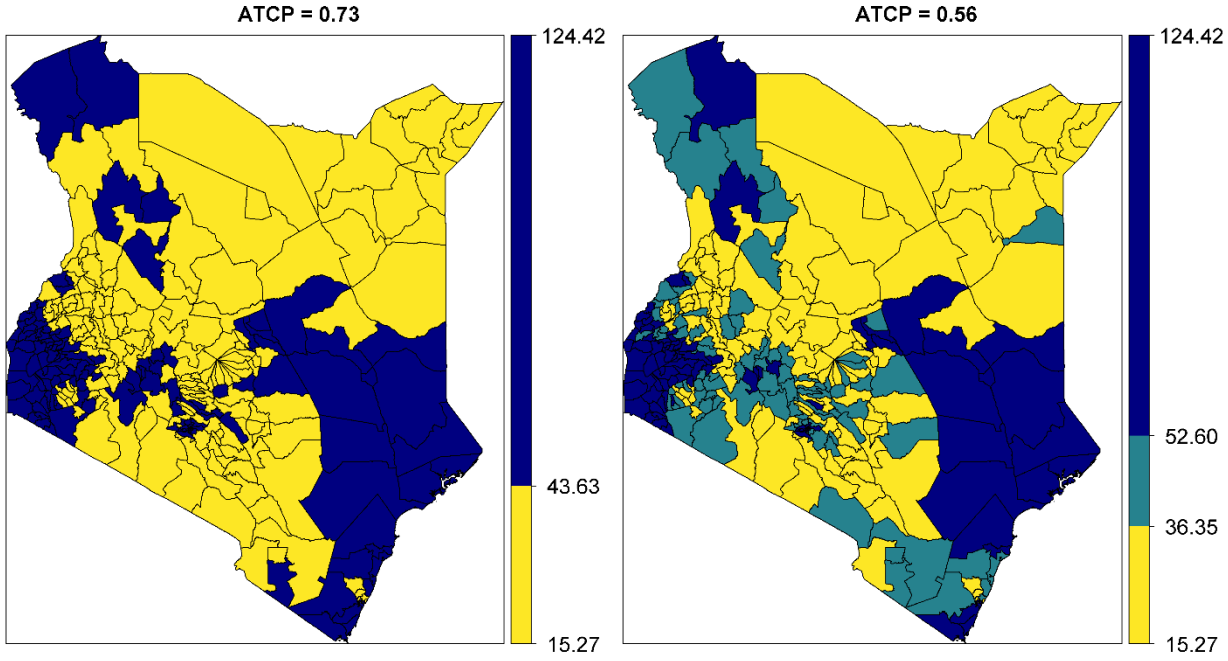
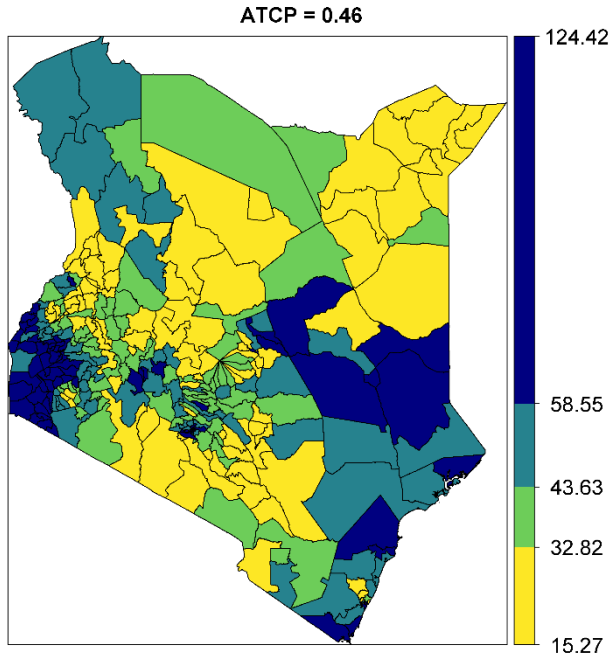


Figure E.13 Average True Classification Probabilities (ATCP) for K = 2, 3, 4 for Kenya in 2014, where K is the number of colors on maps



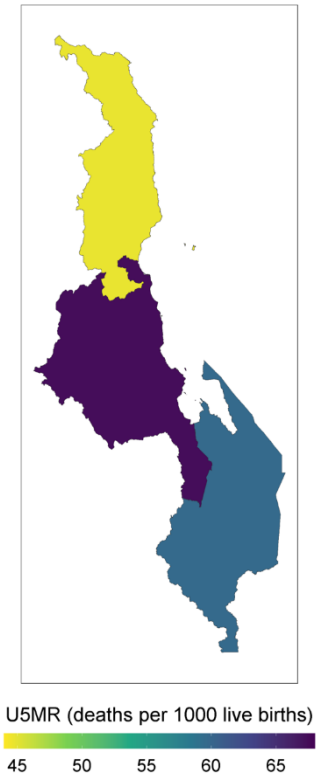
(a) $K = 2$ (b) $K = 3$



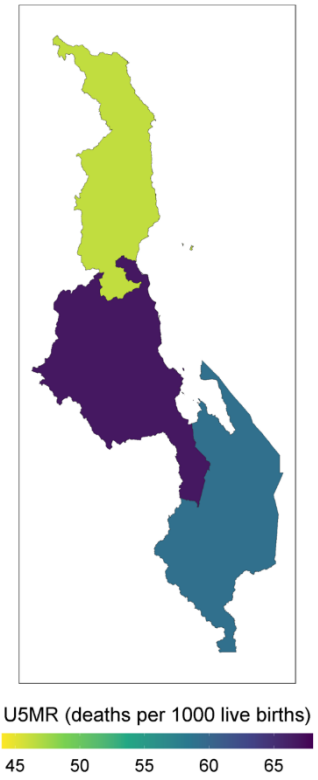
(c) $K = 4$

APPENDIX F DETAILED RESULTS FOR MALAWI

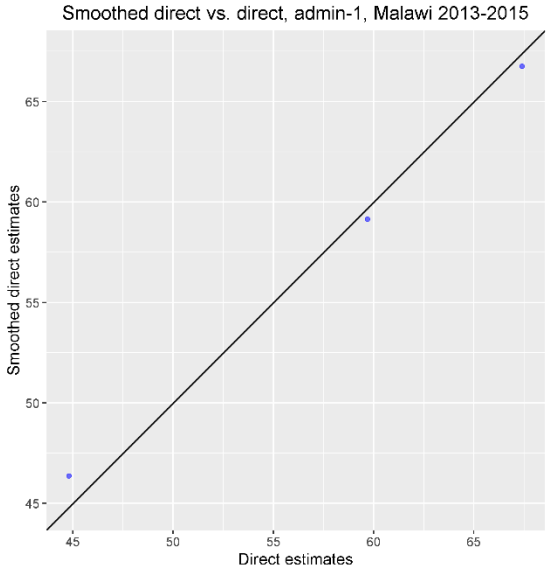
Figure F.1 Comparison of Admin 1 direct and smoothed direct estimates for Malawi 2013-2015



(a) Direct estimates



(b) Smoothed direct estimates



(c) Direct versus smoothed direct estimates

Figure F.2 **Aggregated yearly beta-binomial national estimates versus yearly direct national estimates, over time, and with 95% error bands. The aggregation is from Admin 2 to national.**

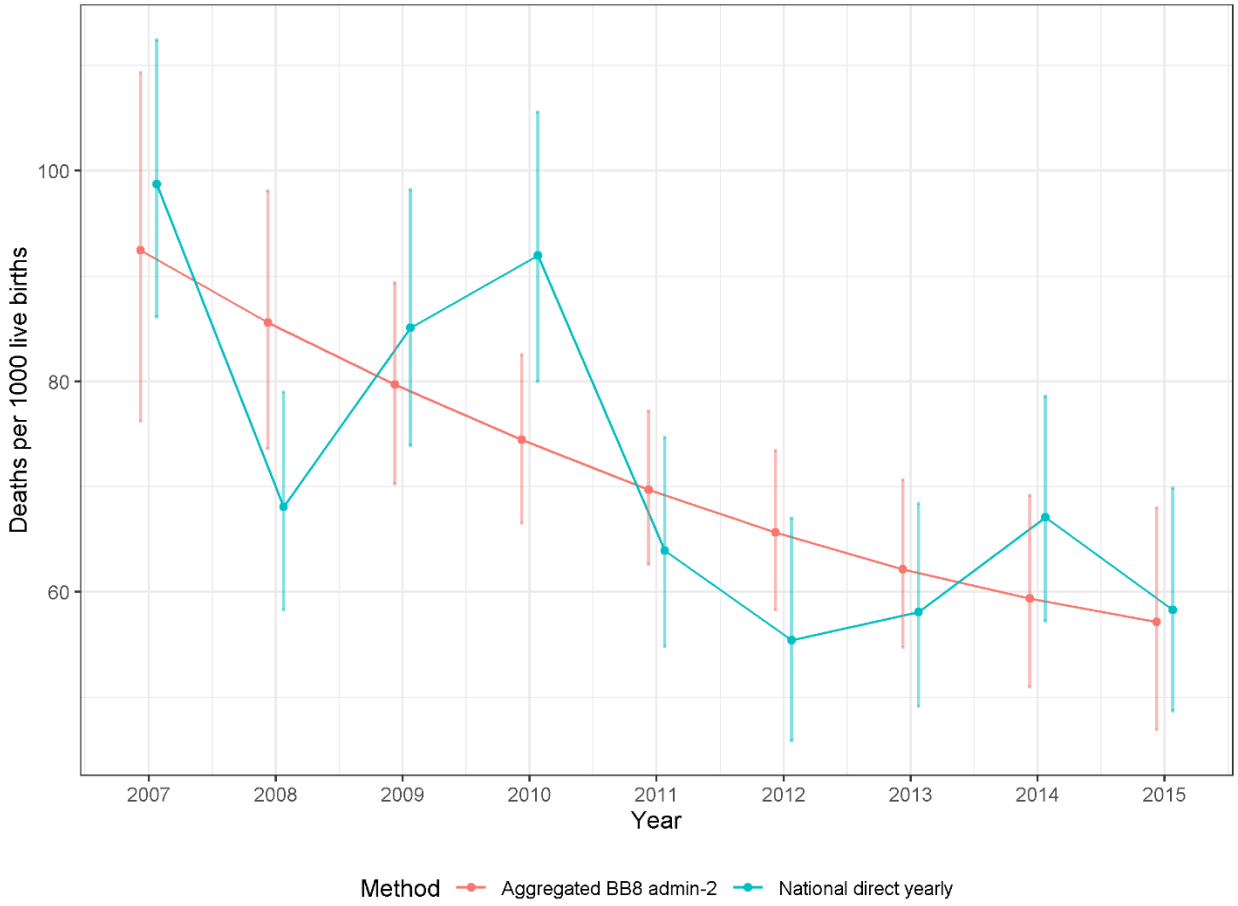


Figure F.3 **Probability for Admin 2 U5MR estimates exceeding national direct estimates for Malawi 2015. National rate over the period 2013-2015 (and its associated 95% CI) is 61.2 (55.6, 67.5) per 1,000 live births.**

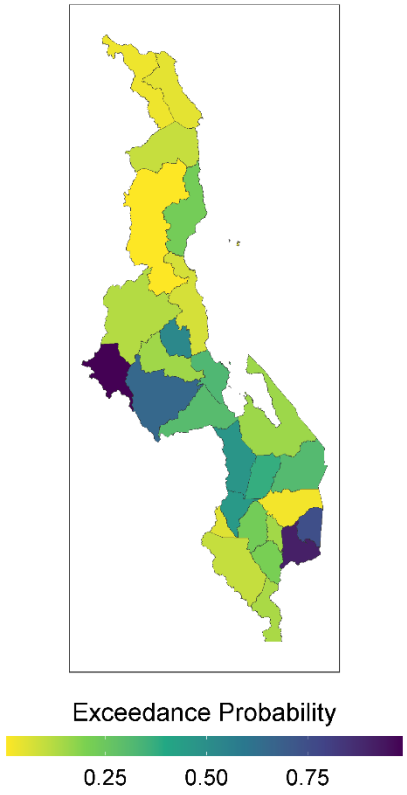


Figure F.4 **Odds ratios (urban/rural) over time for the age bands 0-1 months, 1-12 months, >12 months**

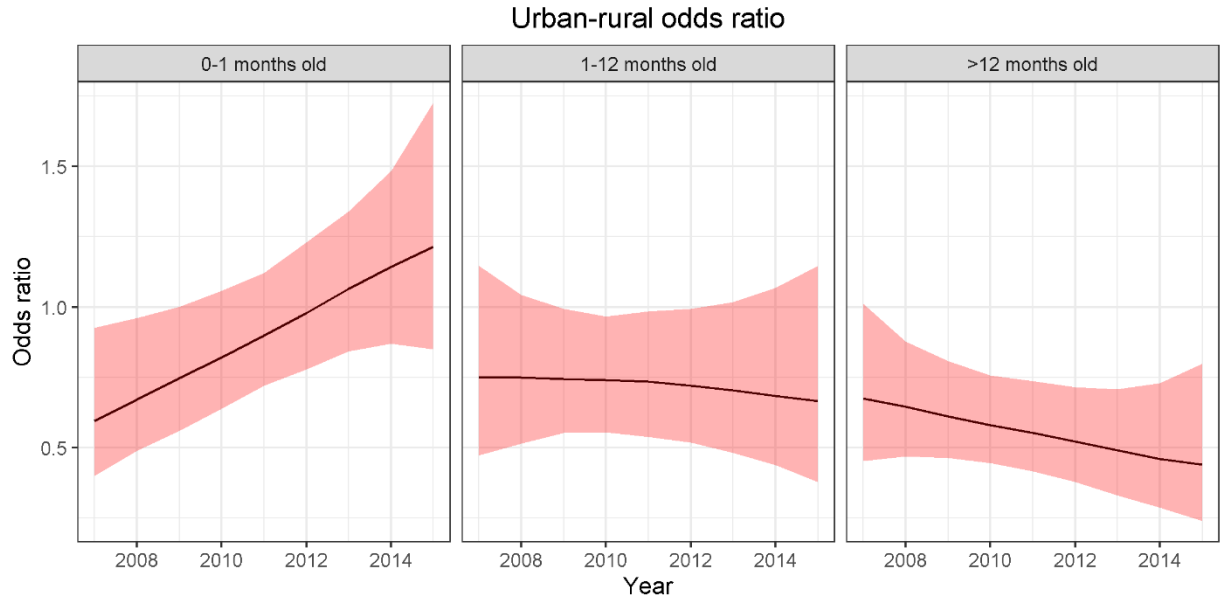


Figure F.5 Malawi Admin 1 U5MR estimates for 2007-2015

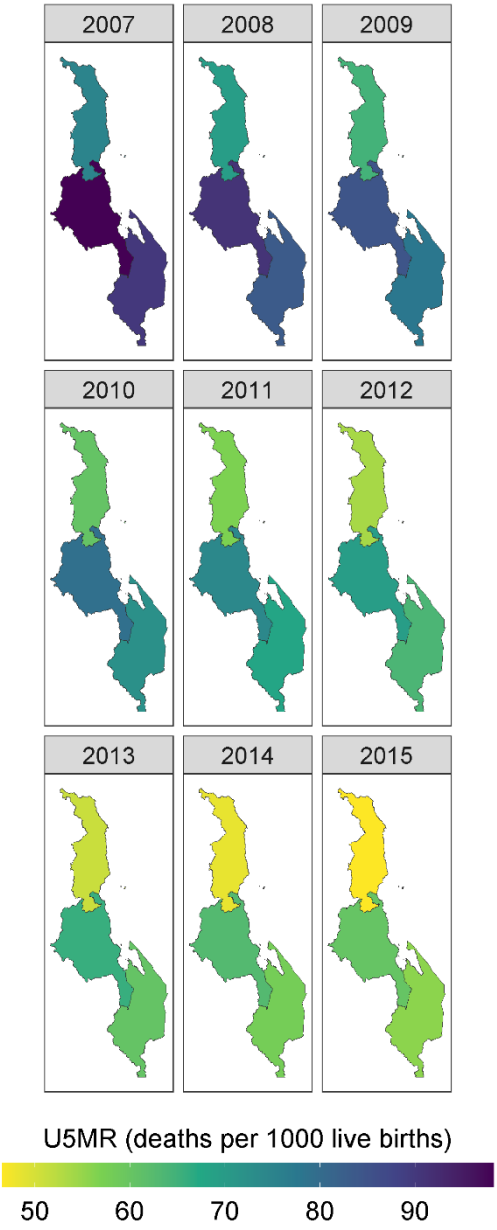


Figure F.6 Malawi Admin 1 U5MR 95% credible interval width for 2007-2015

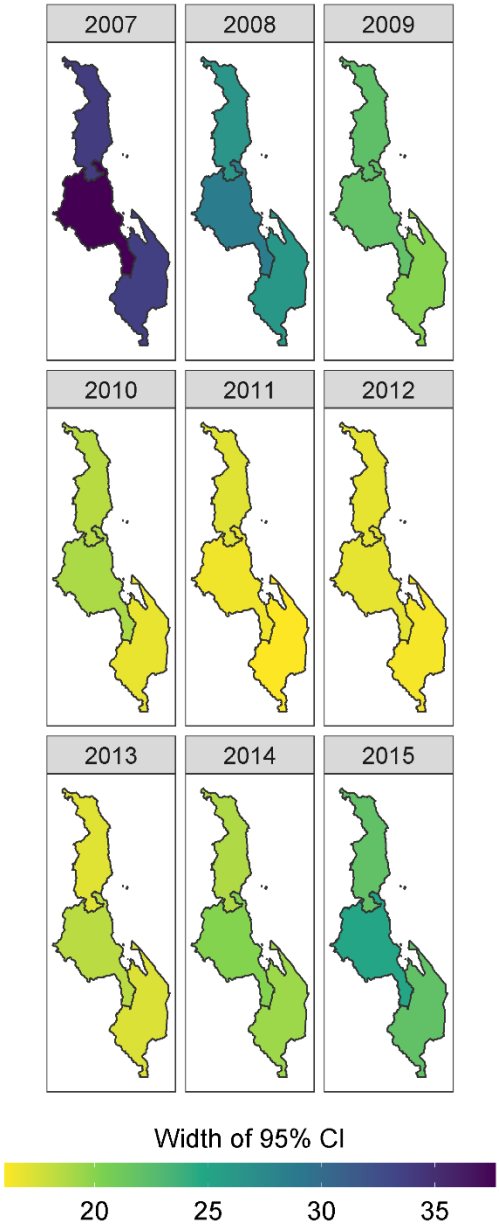


Figure F.7 Malawi Admin 1 U5MR estimates by year with associated 95% credible intervals for 2007-2015

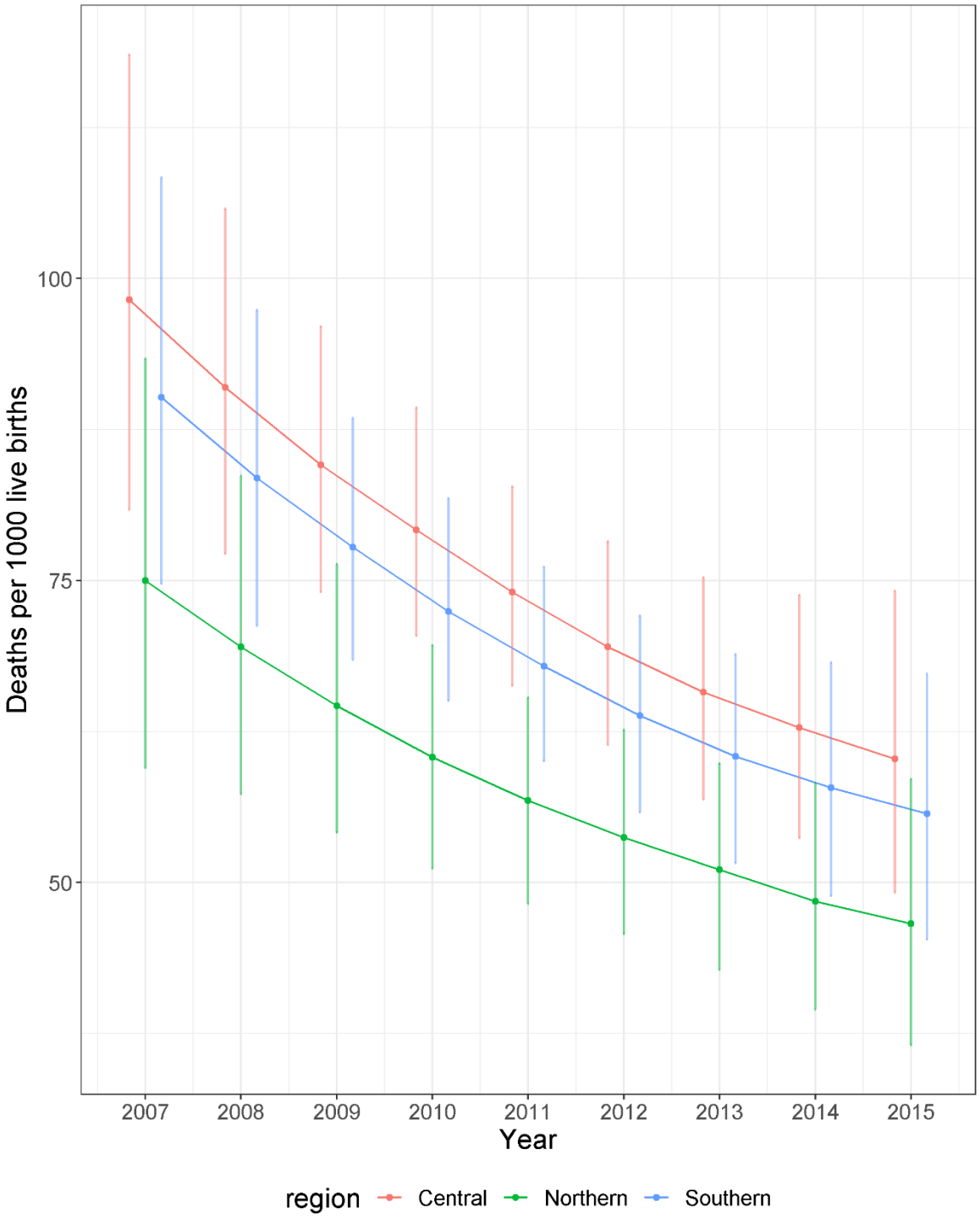


Figure F.8 Malawi Admin 2 U5MR estimates for 2007-2015

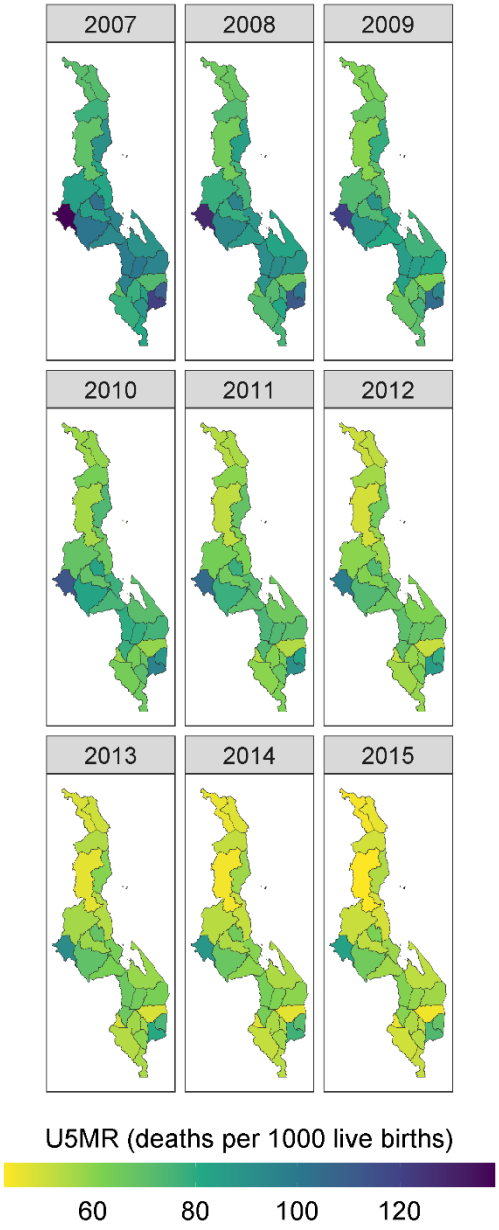


Figure F.9 Malawi Admin 2 U5MR 95% credible interval width for 2007-2015

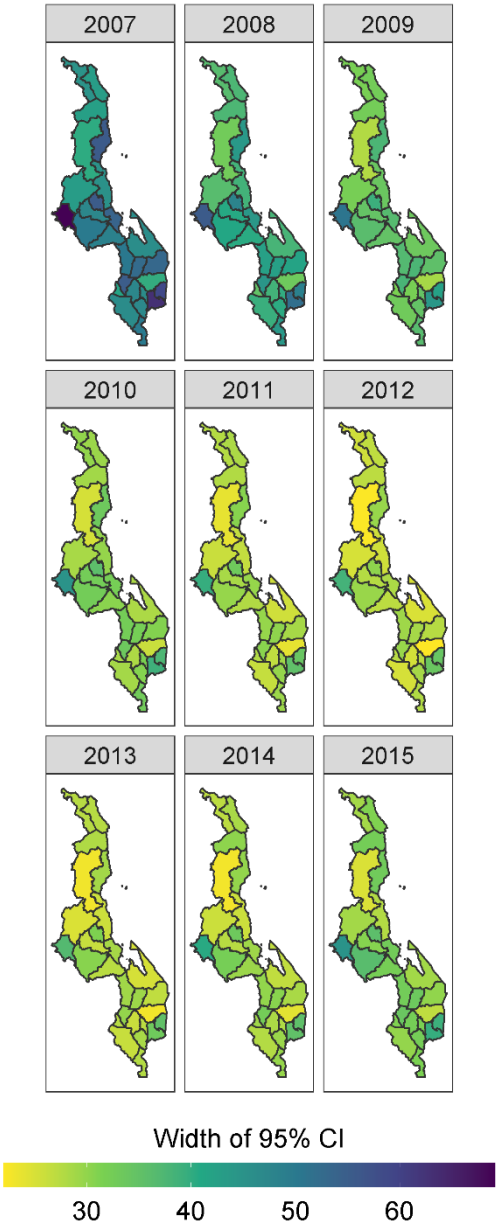


Figure F.10 Malawi Admin 2 U5MR estimates by year for 2007-2015

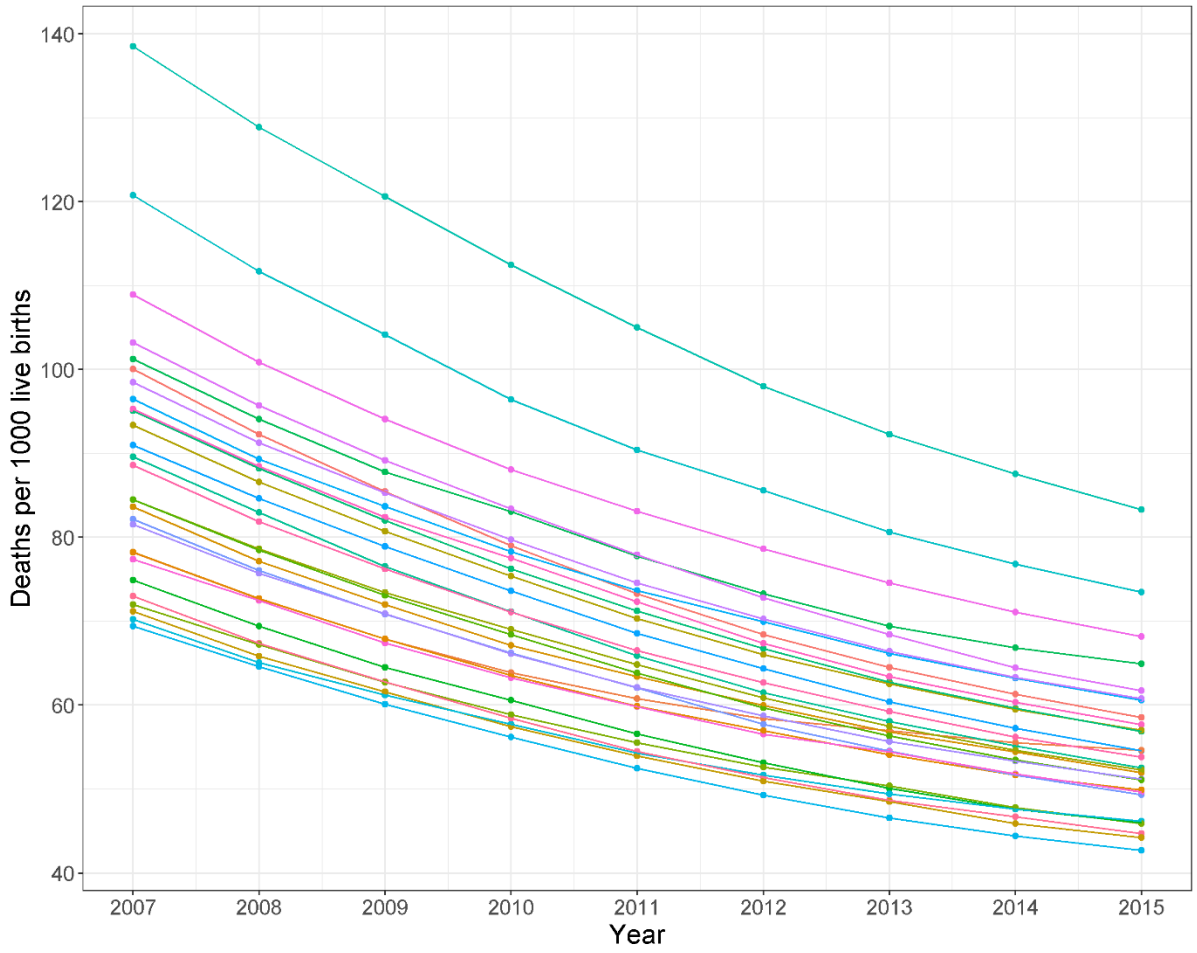


Figure F.11 Ridgeplot representation of posterior distribution of Admin 2 U5MR for Malawi in 2015. On the top we show the regions with the lowest posterior median U5MR, and on the bottom those with the highest U5MR.

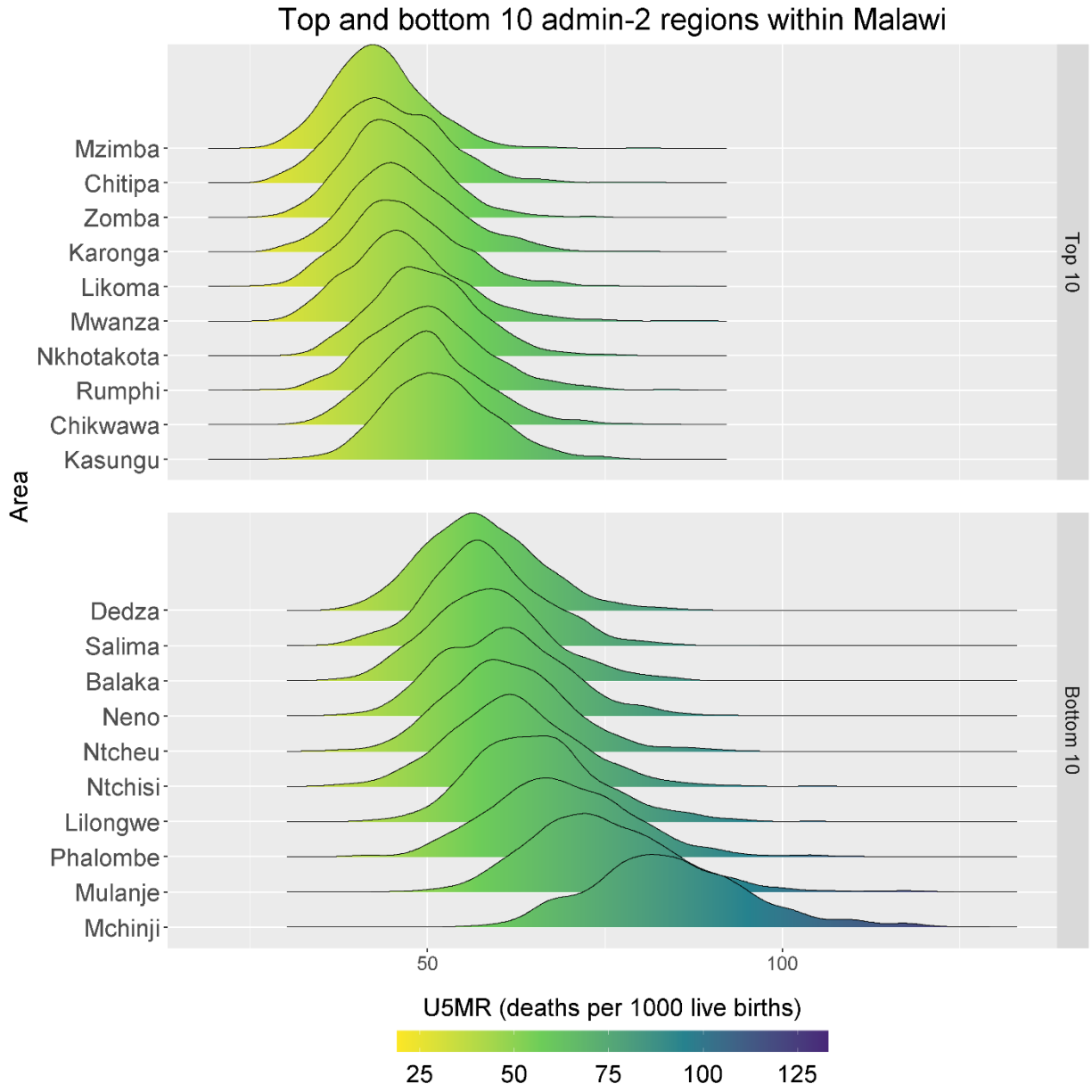


Figure F.12 Estimated Admin 2 U5MR ranking for Malawi in 2015. On the left we show the regions with the highest U5MR, and on the right those with the lowest U5MR. The expected ranking (ER) of each area is also given.

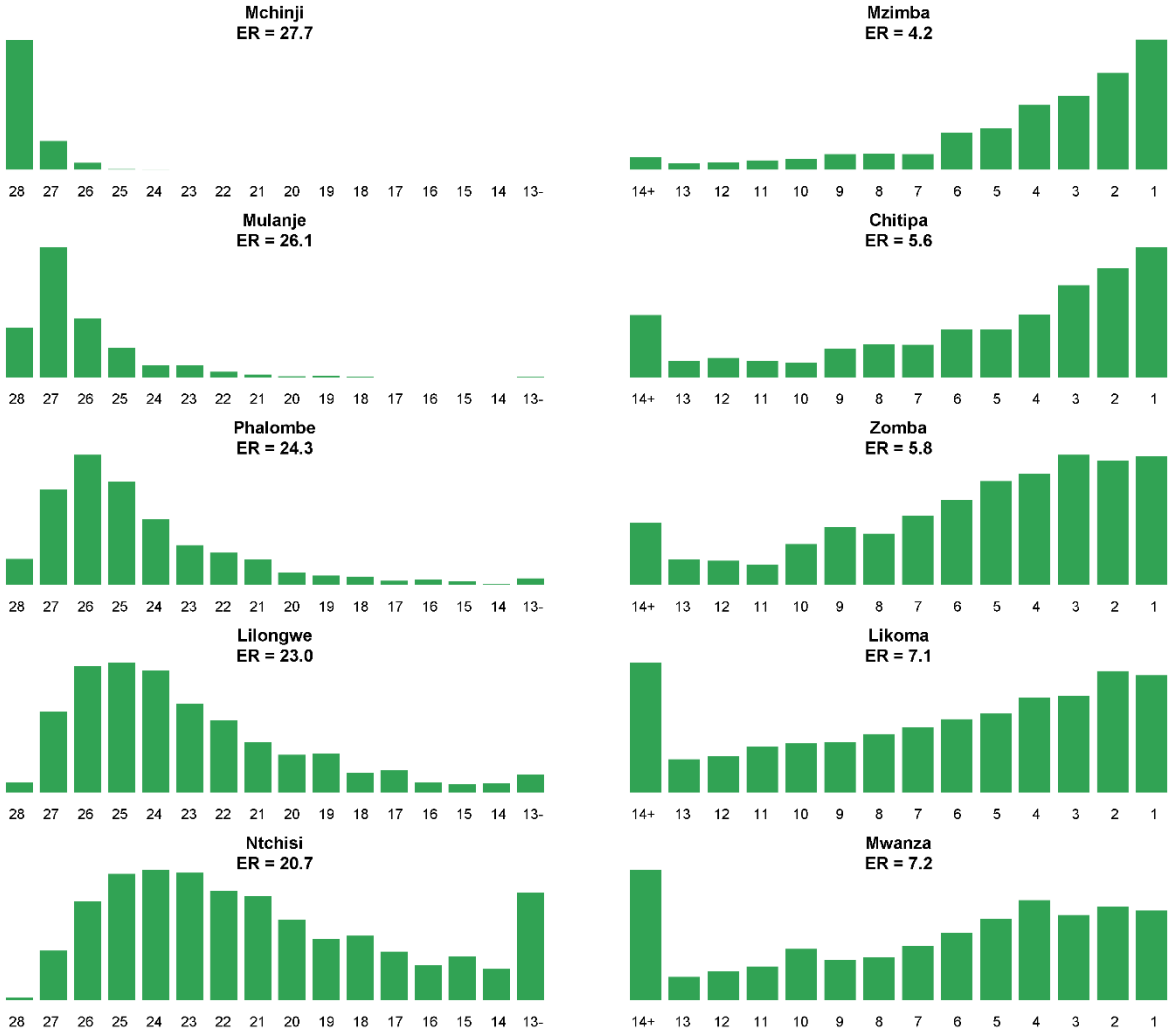
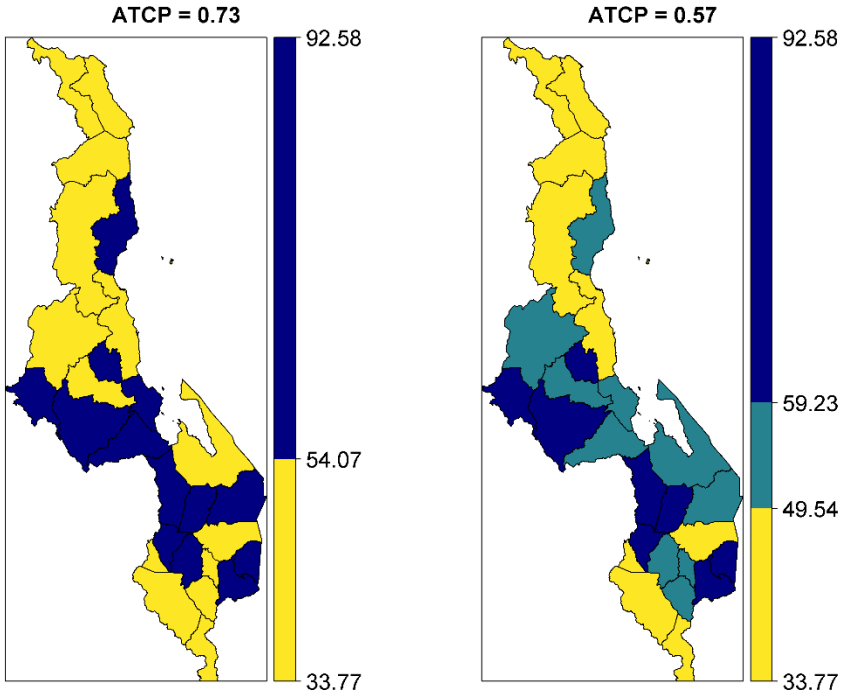
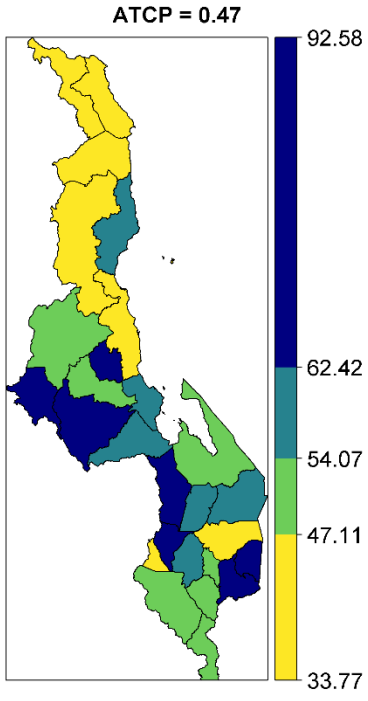


Figure F.13 Average True Classification Probabilities (ATCP) for K = 2, 3, 4 for Malawi in 2015, where K is the number of colors on maps



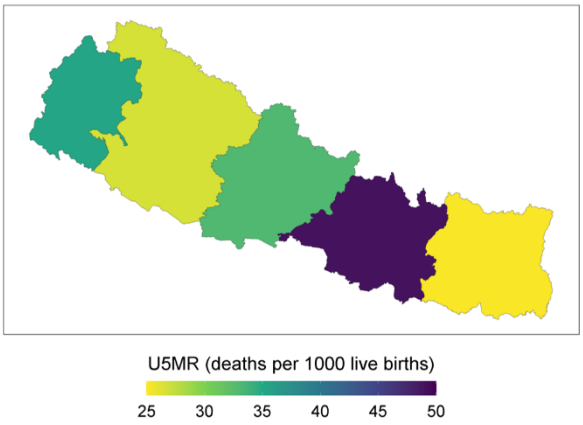
(a) $K = 2$ (b) $K = 3$



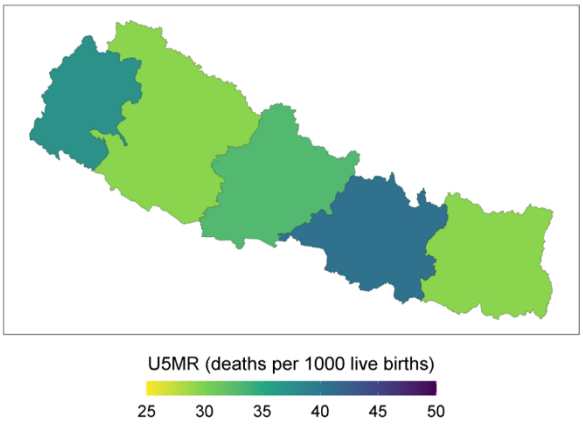
(c) $K = 4$

APPENDIX G DETAILED RESULTS FOR NEPAL

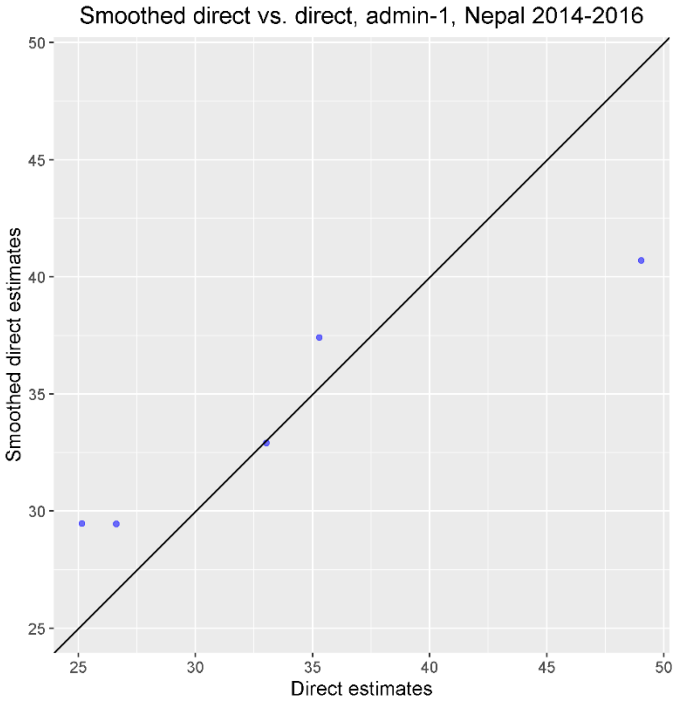
Figure G.1 Comparison of Admin 1 direct and smoothed direct estimates for Nepal 2014-2016



(a) Direct estimates



(b) Smoothed direct estimates



(c) Direct versus smoothed direct estimates

Figure G.2 Aggregated yearly beta-binomial national estimates versus yearly direct national estimates, over time, and with 95% error bands. The aggregation is from Admin 2 to national.

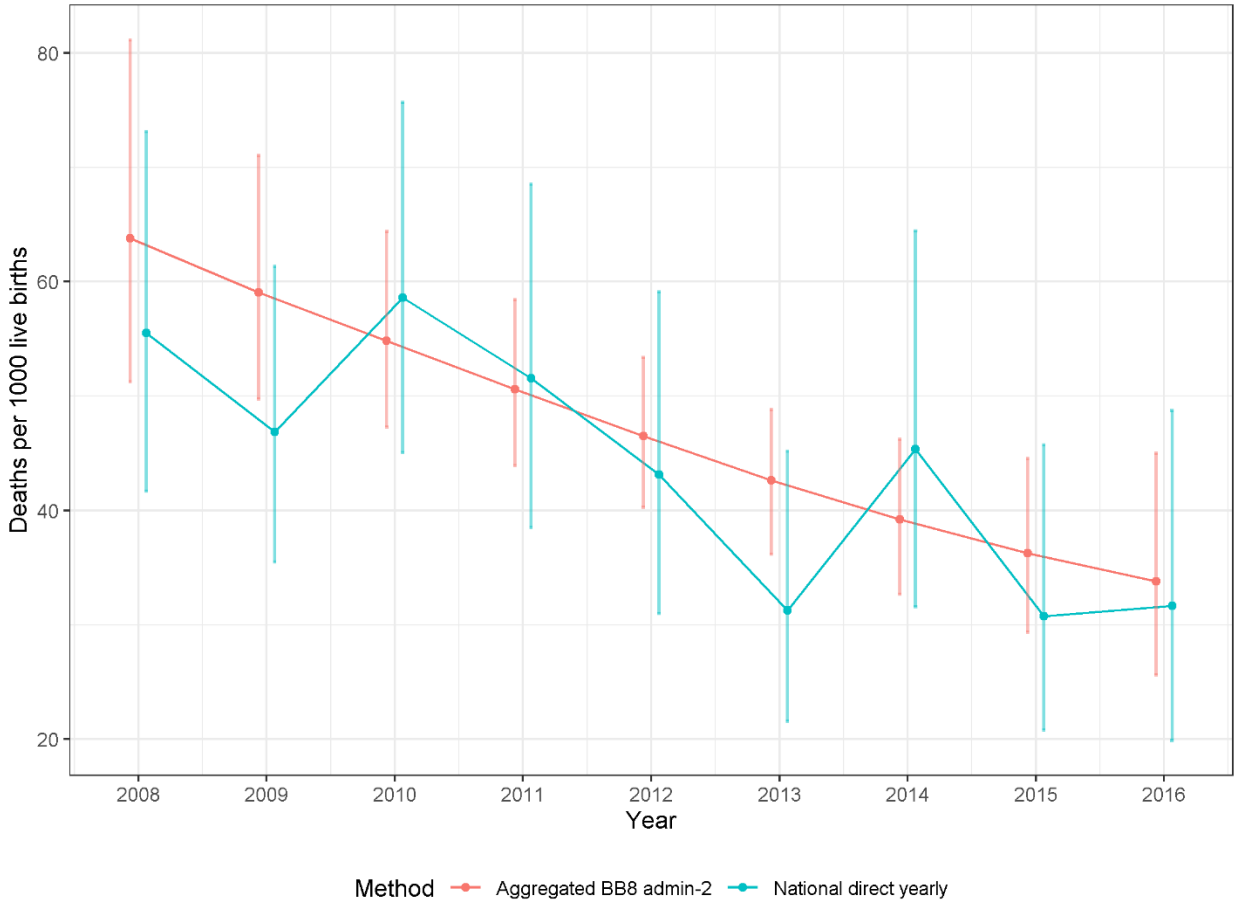


Figure G.3 Probability for Admin 2 U5MR estimates exceeding national direct estimates for Nepal 2016. National rate over the period 2014-2016 (and its associated 95% CI) is 36.3 (28.8, 45.5) per 1,000 live births.

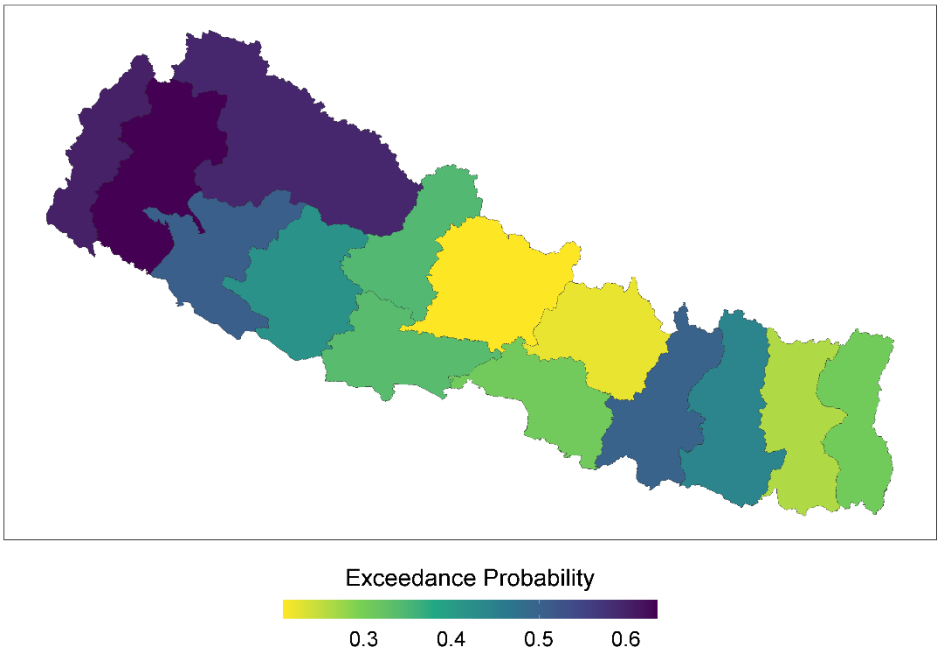


Figure G.4 Odds ratios (urban/rural) over time for the age bands 0-1 months, 1-12 months, >12 months

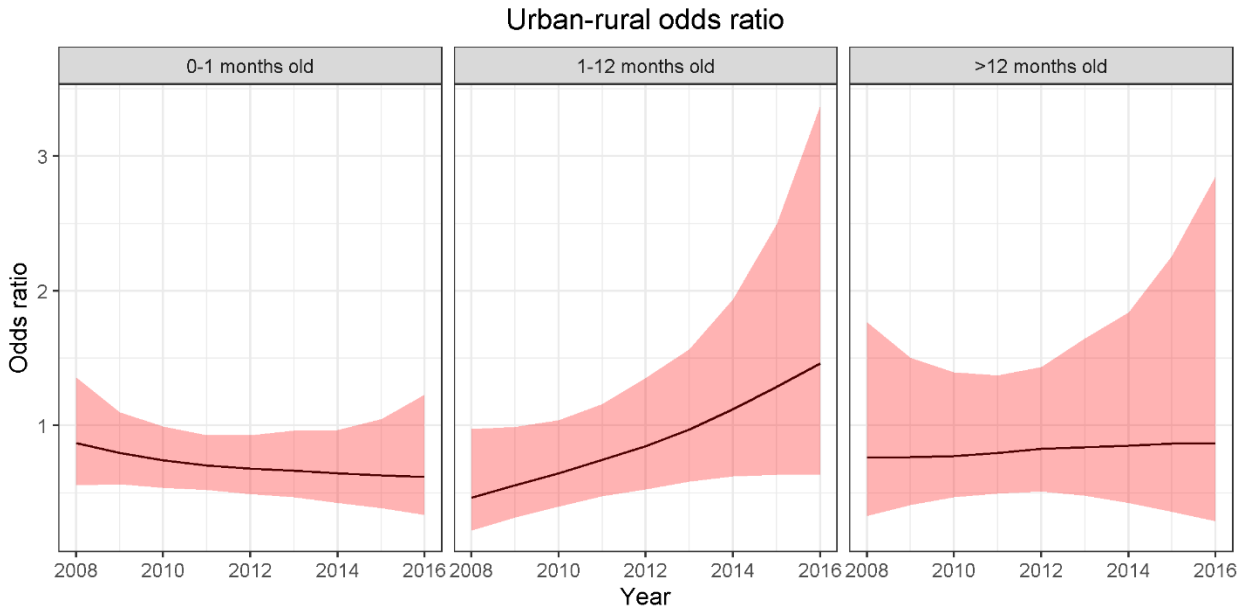


Figure G.5 Nepal Admin 1 U5MR estimates for 2008-2016

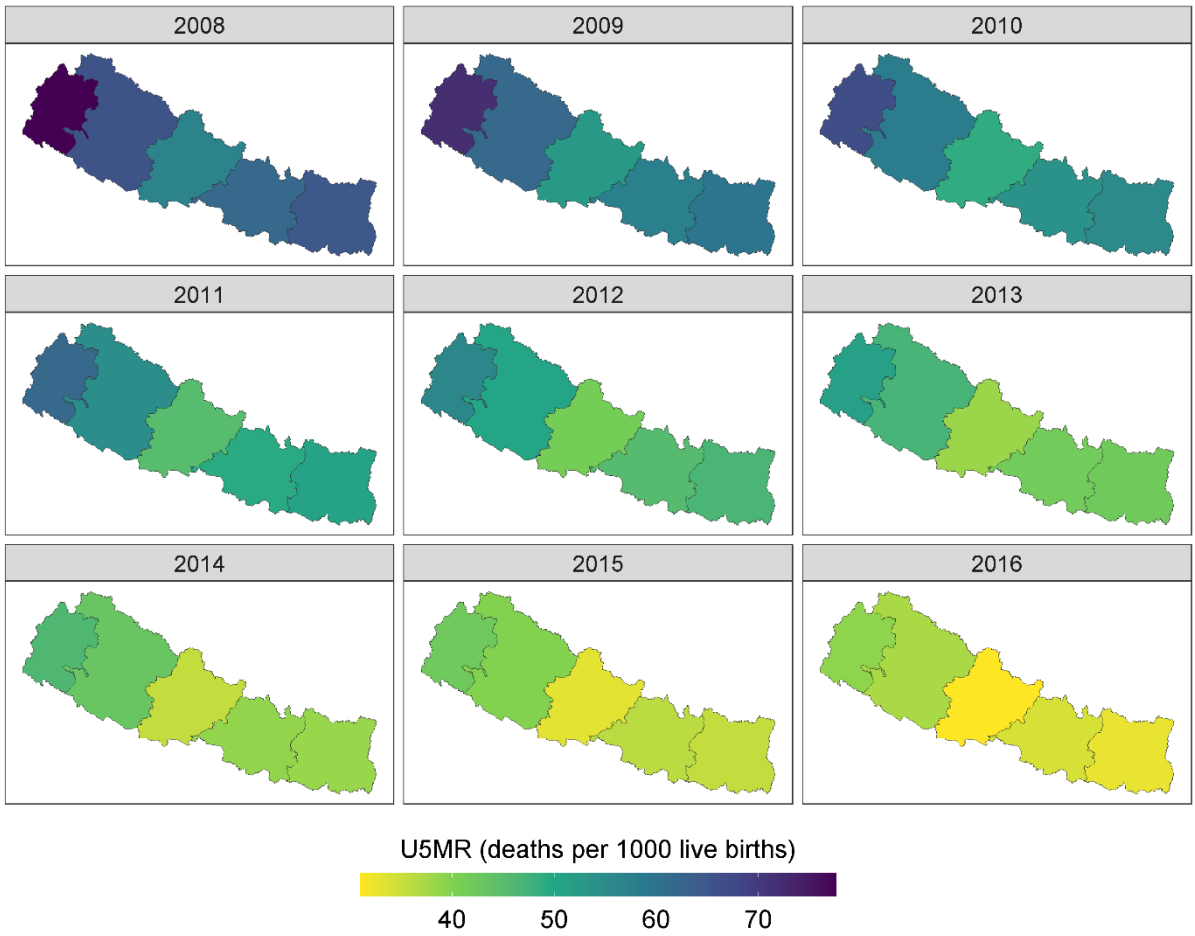


Figure G.6 Nepal Admin 1 U5MR 95% credible interval width for 2008-2016

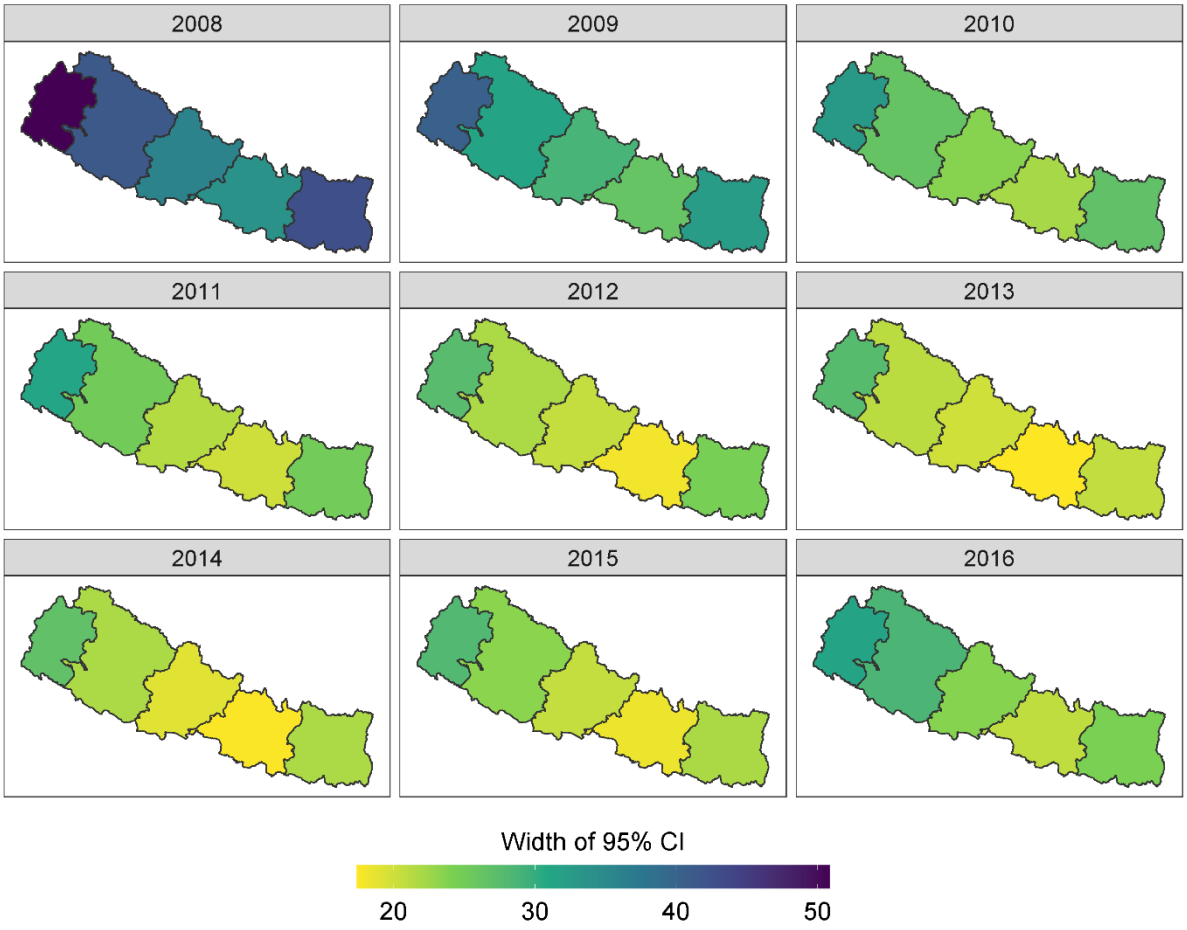


Figure G.7 Nepal Admin 1 U5MR estimates by year with associated 95% credible intervals for 2008-2016

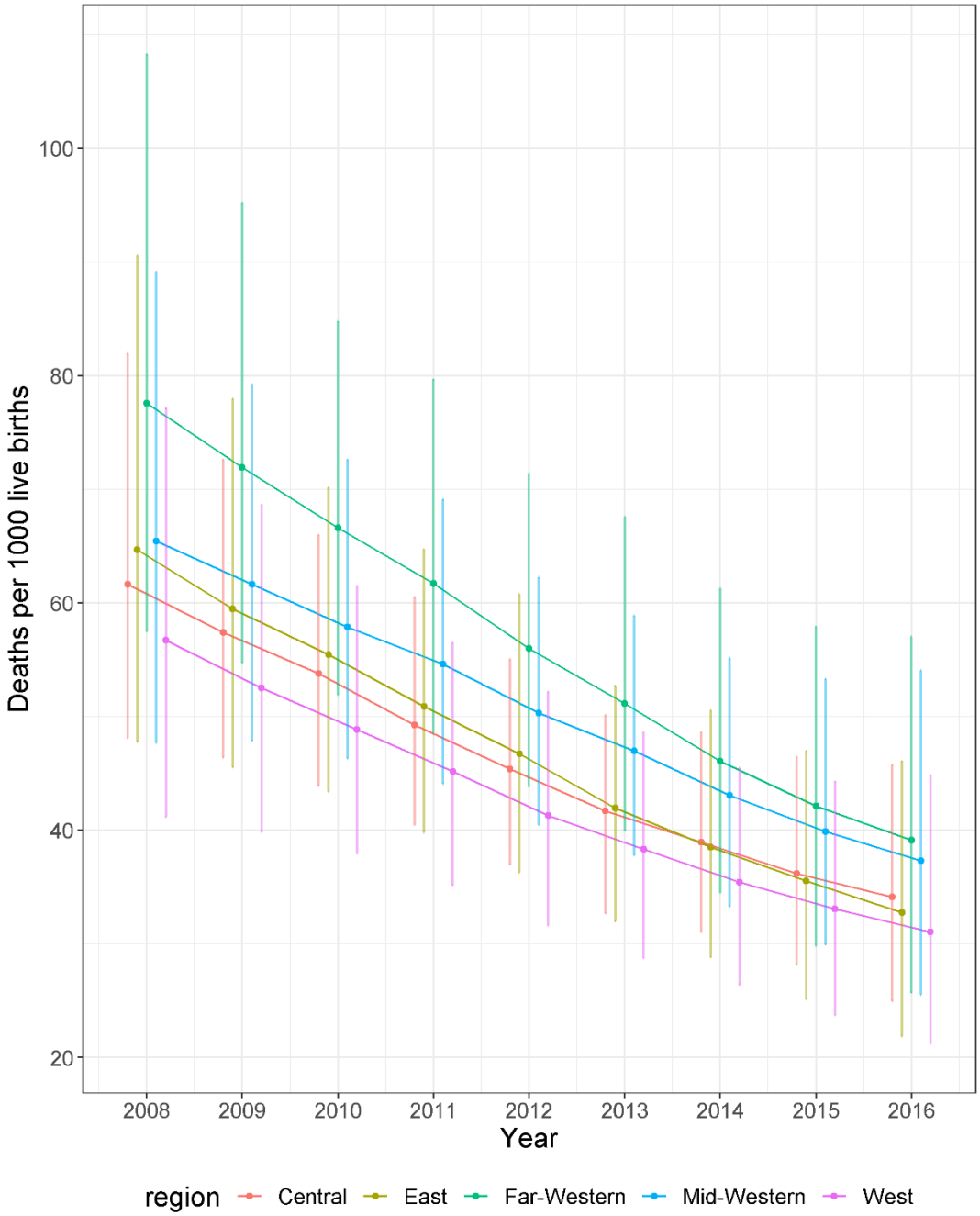


Figure G.8 Nepal Admin 2 U5MR estimates for 2008-2016

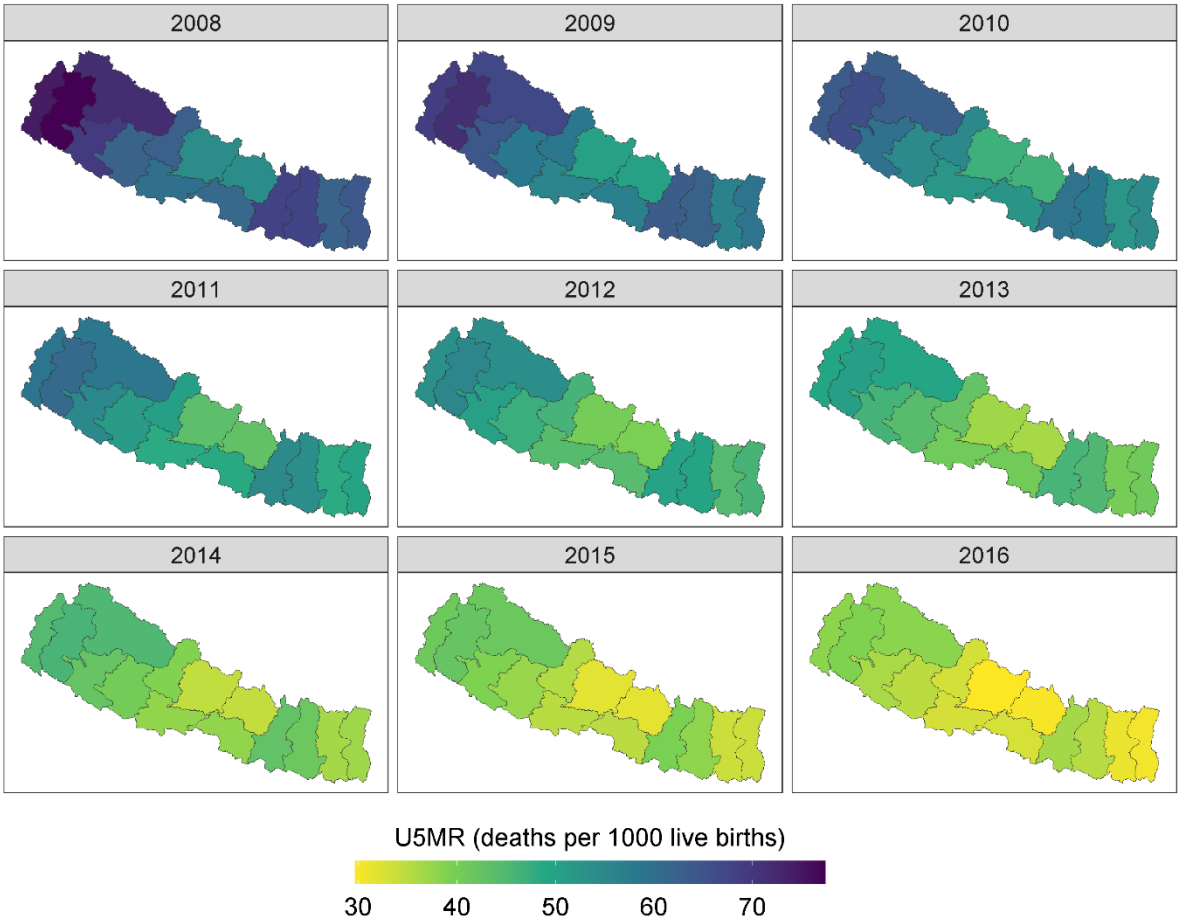


Figure G.9 Nepal Admin 2 U5MR 95% credible interval width for 2008-2016

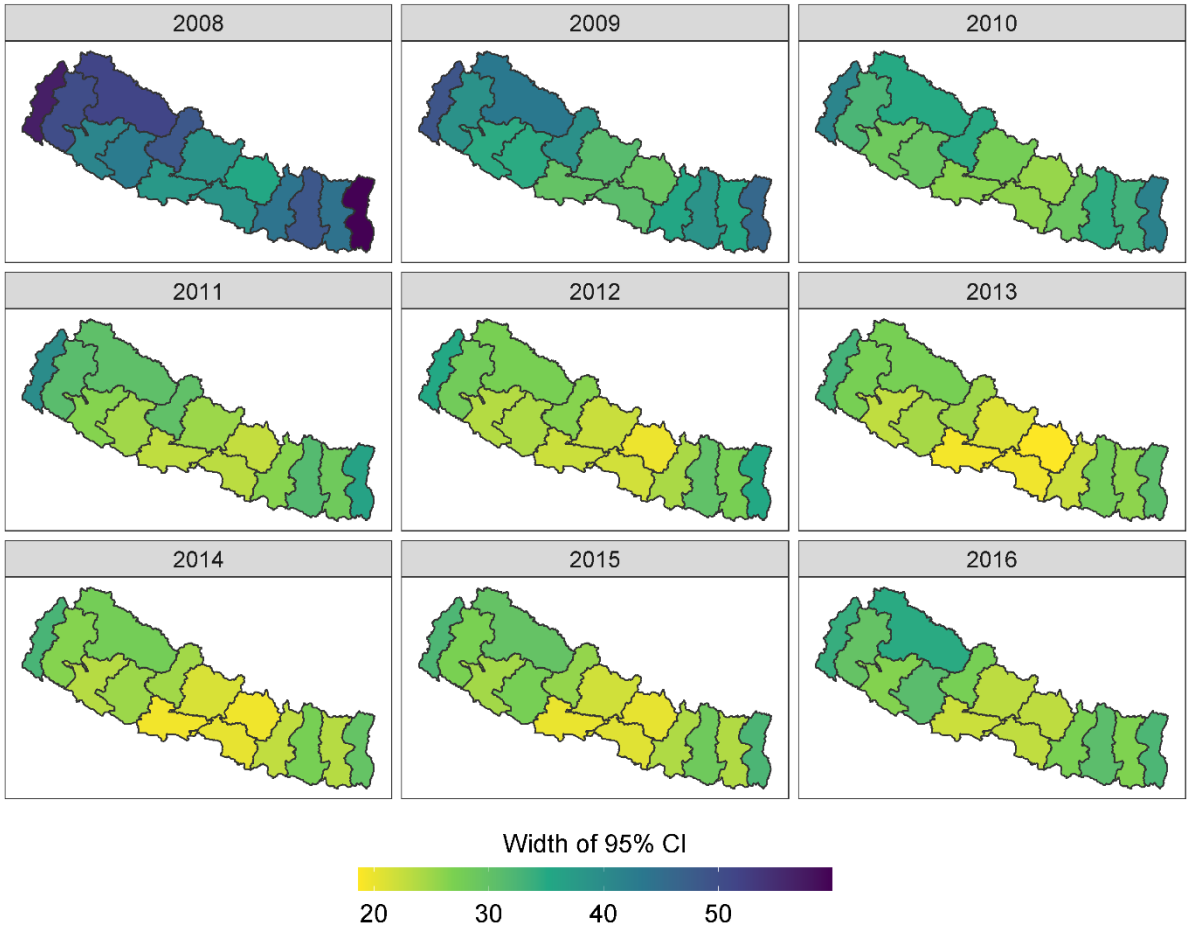


Figure G.10 Nepal Admin 2 U5MR estimates by year for 2008-2016

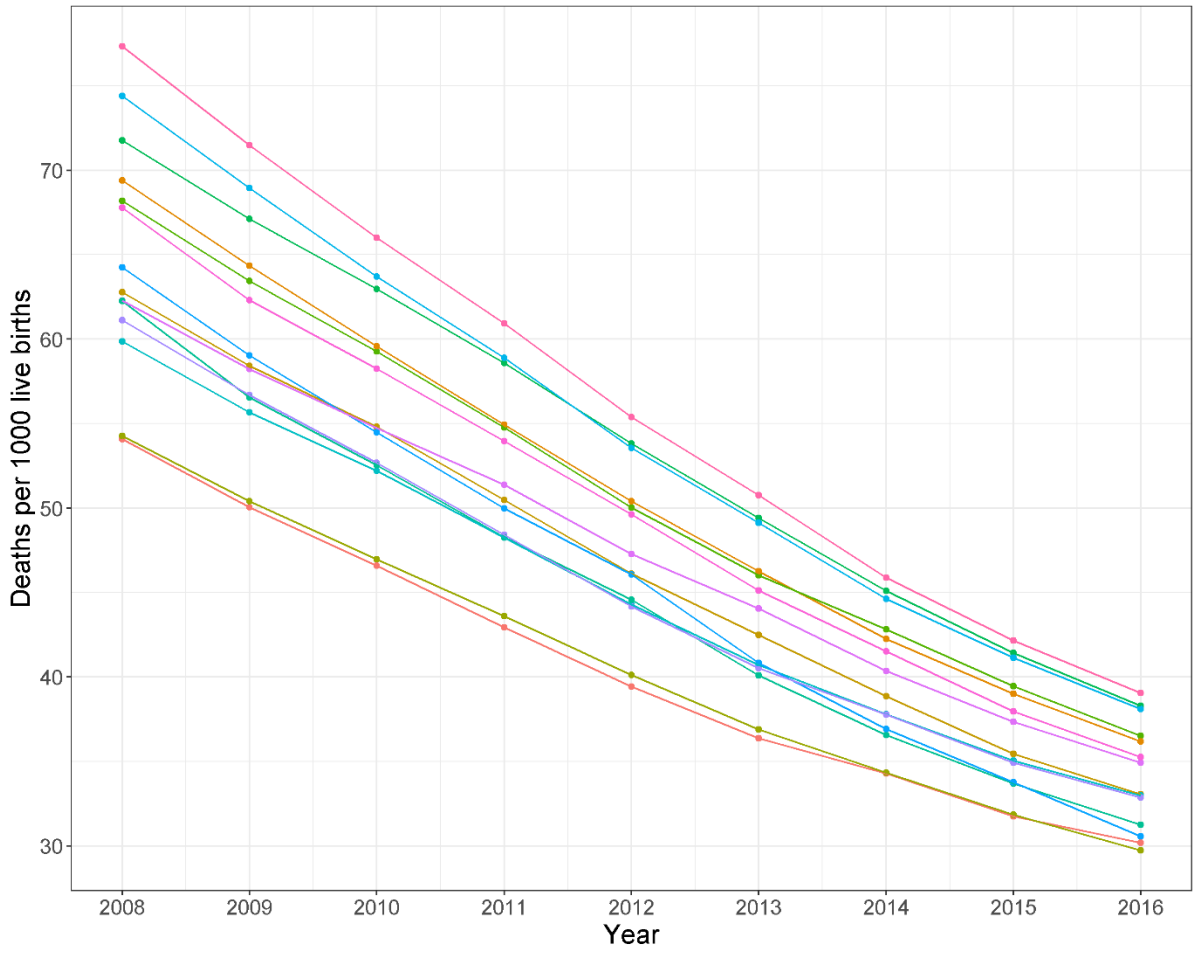


Figure G.11 Ridgeplot representation of posterior distribution of Admin 2 U5MR for Nepal in 2016

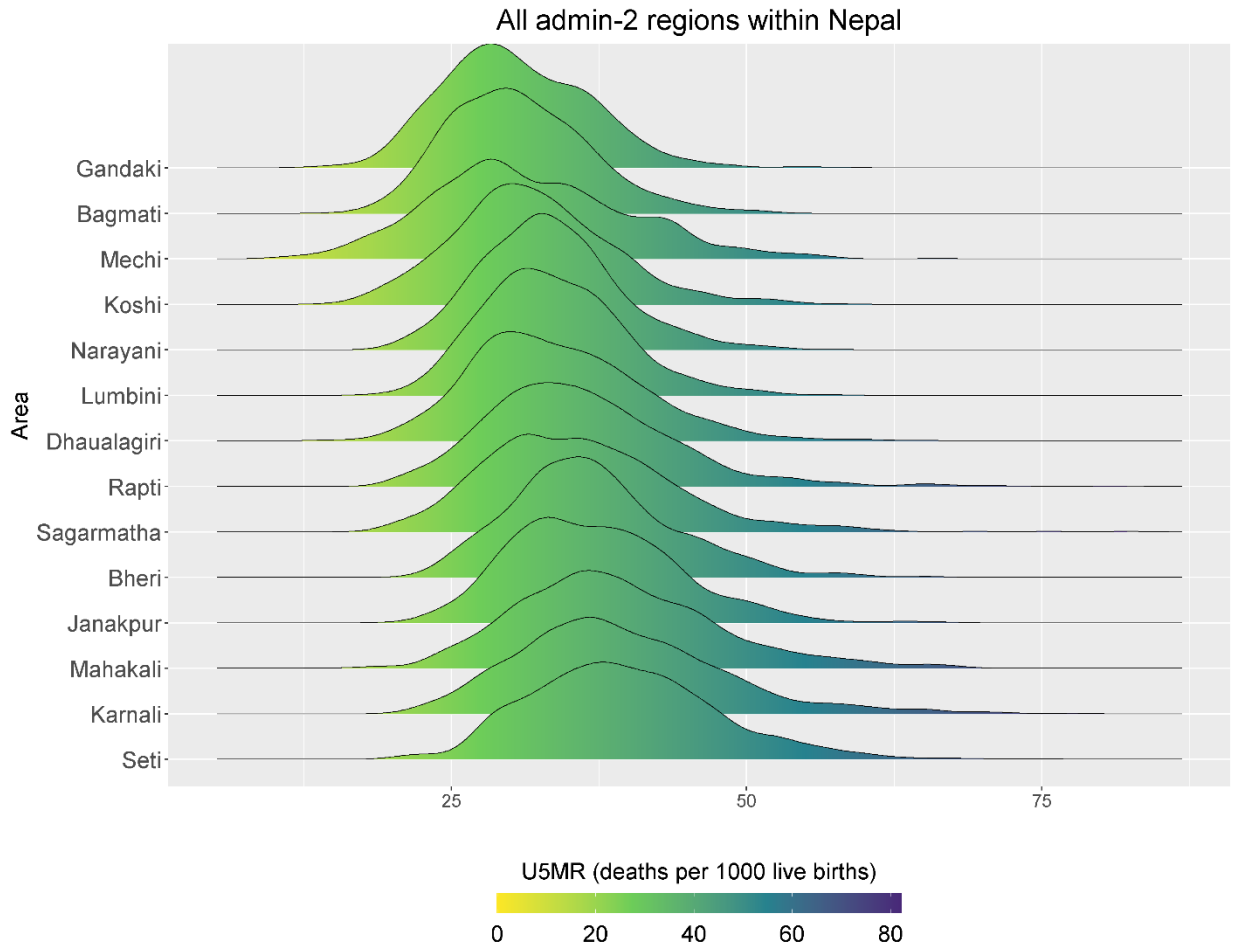


Figure G.12 **Estimated Admin 2 U5MR ranking for Nepal in 2016. On the left we show the regions with the highest U5MR, and on the right those with the lowest U5MR. The expected ranking (ER) of each area is also given.**

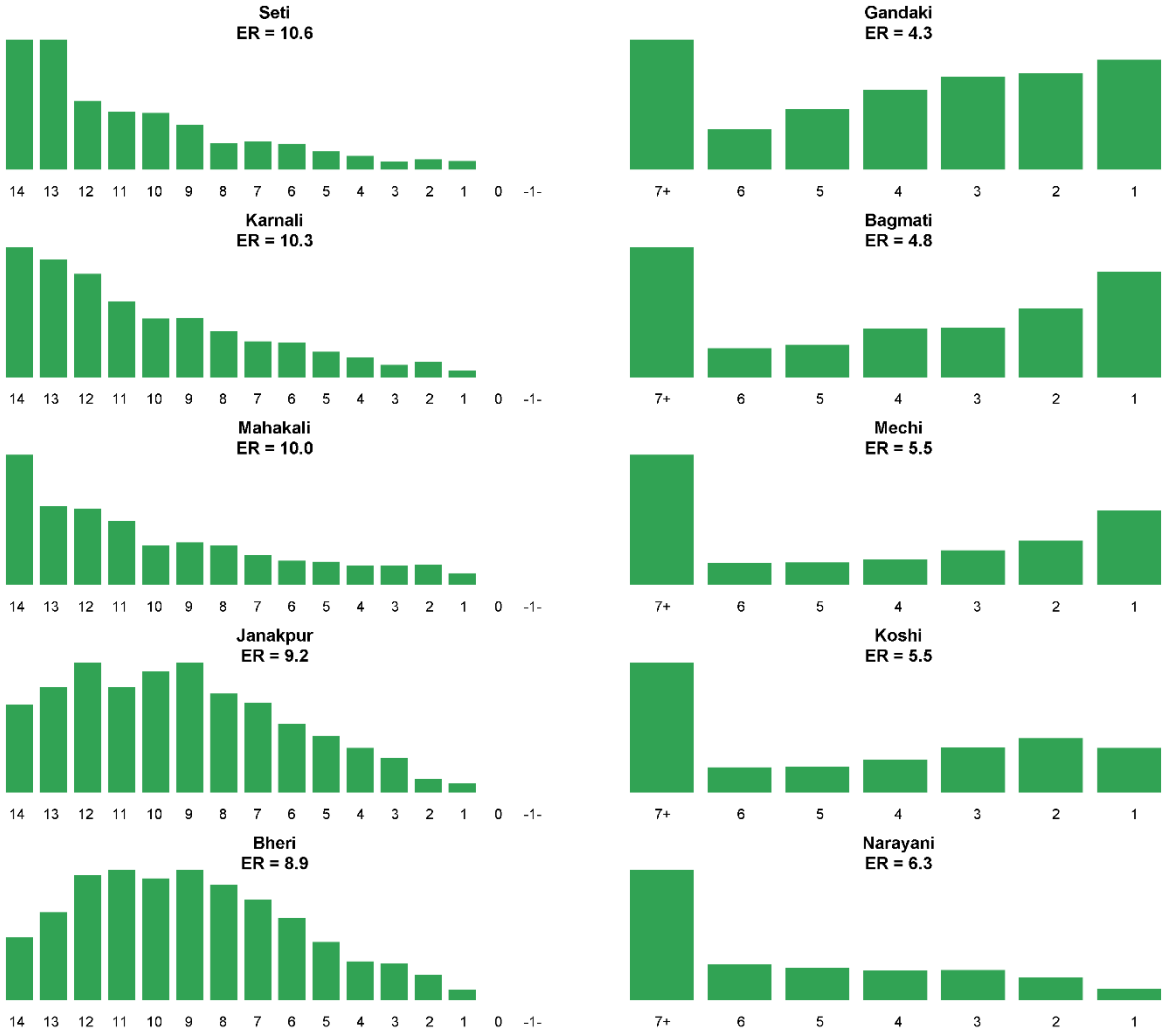
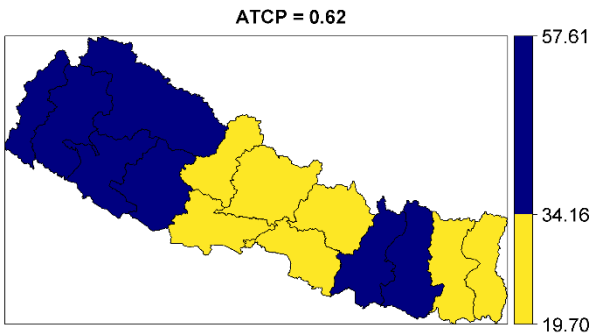
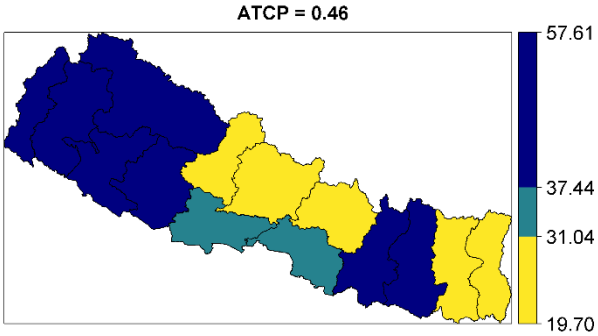


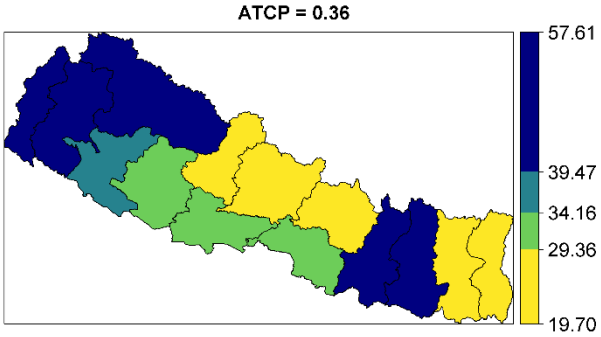
Figure G.13 Average True Classification Probabilities (ATCP) for K = 2, 3, 4 for Nepal in 2016, where K is the number of colors on maps



(a) $K = 2$



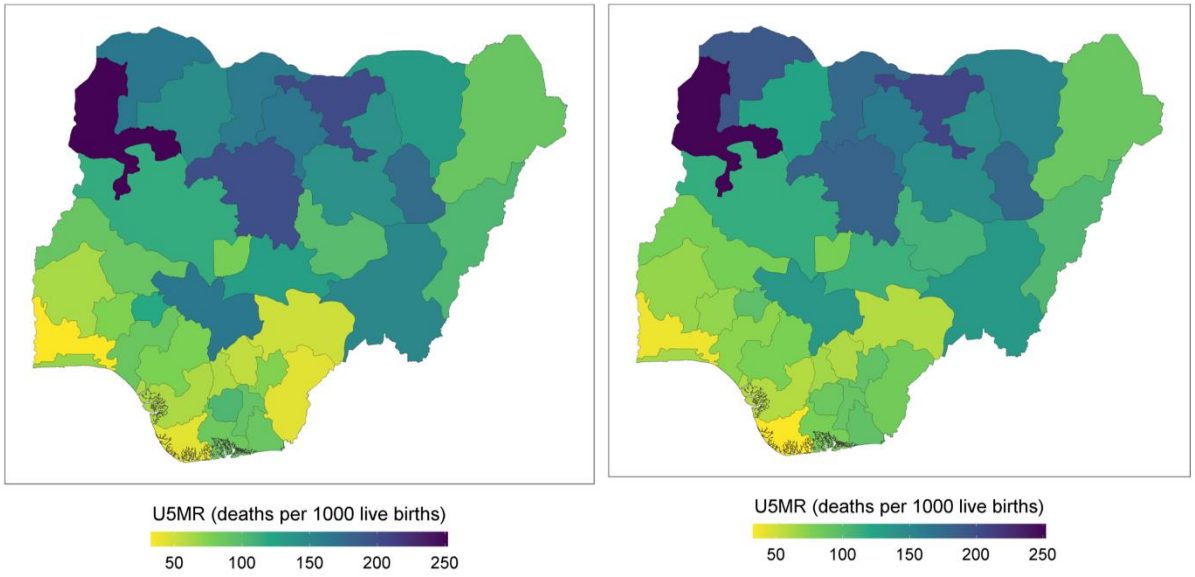
(b) $K = 3$



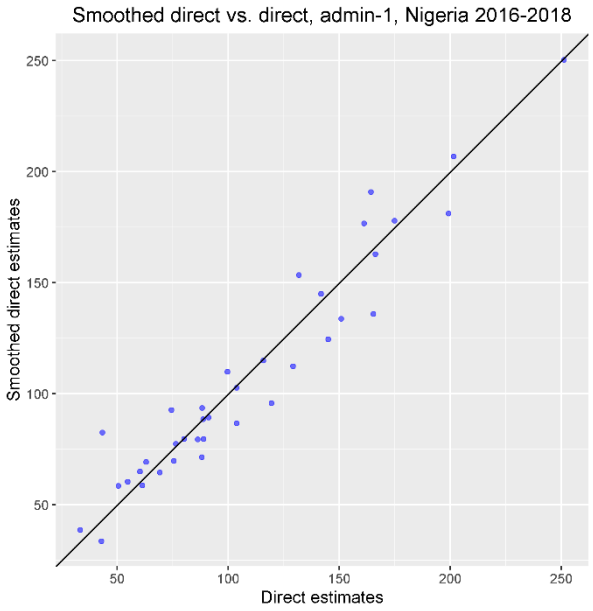
(c) $K = 4$

APPENDIX H DETAILED RESULTS FOR NIGERIA

Figure H.1 Comparison of Admin 1 direct and smoothed direct estimates for Nigeria 2016-2018



(a) Direct estimates (b) Smoothed direct estimates



(c) Direct versus smoothed direct estimates

Figure H.2 Aggregated yearly beta-binomial national estimates versus yearly direct national estimates, over time, and with 95% error bands. The aggregation is from Admin 2 to national.

The aggregated yearly beta-binomial national estimates are systematically lower than the yearly direct national estimates for Nigeria. Nigeria has 774 regions, and it is hard to ensure all of the space-time components for the aggregation process behave well with so many regions. In particular, we have imposed a lot of space-time smoothing in the beta-binomial model to produce 774 estimates by time by age bands based on sparse data. This smoothing may not play well with aggregation where mixing weights can vary a lot by region (and the weights are very much approximations). The discrepancy warns us that we should not produce national estimates through the space-time approach, which is designed to provide Admin 2 estimates. For national estimates, one should use a different approach to acknowledge the survey design to directly estimate at the national level.

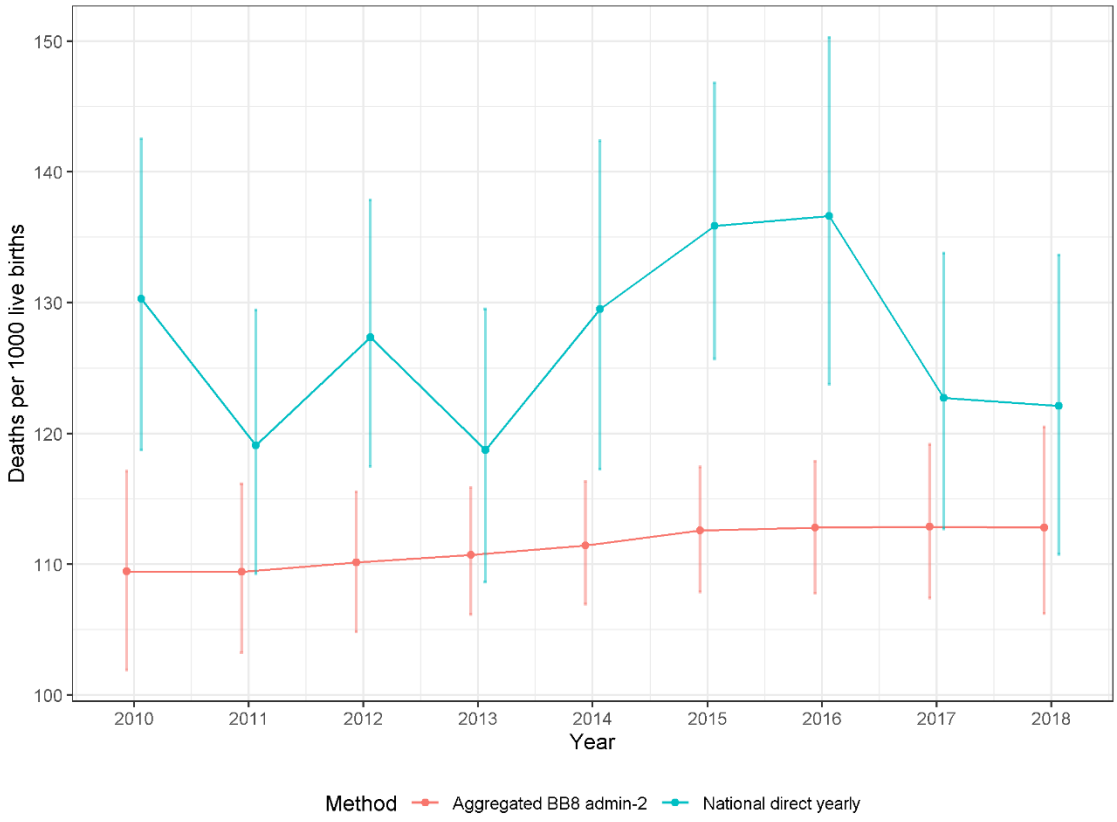


Figure H.3 Probability for Admin 2 U5MR estimates exceeding national direct estimates for Nigeria 2018. National rate over the period 2016-2018 (and its associated 95% CI) is 127.5 (119.7, 135.7) per 1,000 live births.

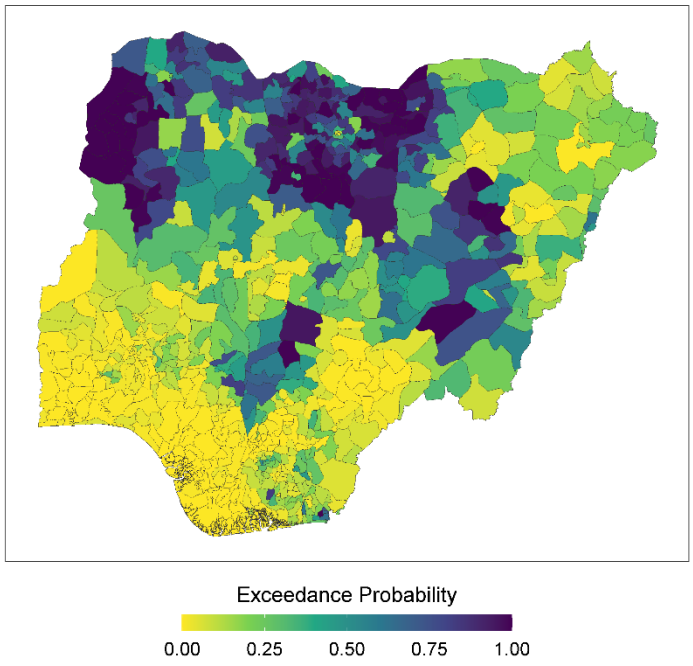


Figure H.4 Odds ratios (urban/rural) over time for the age bands 0-1 months, 1-12 months, >12 months

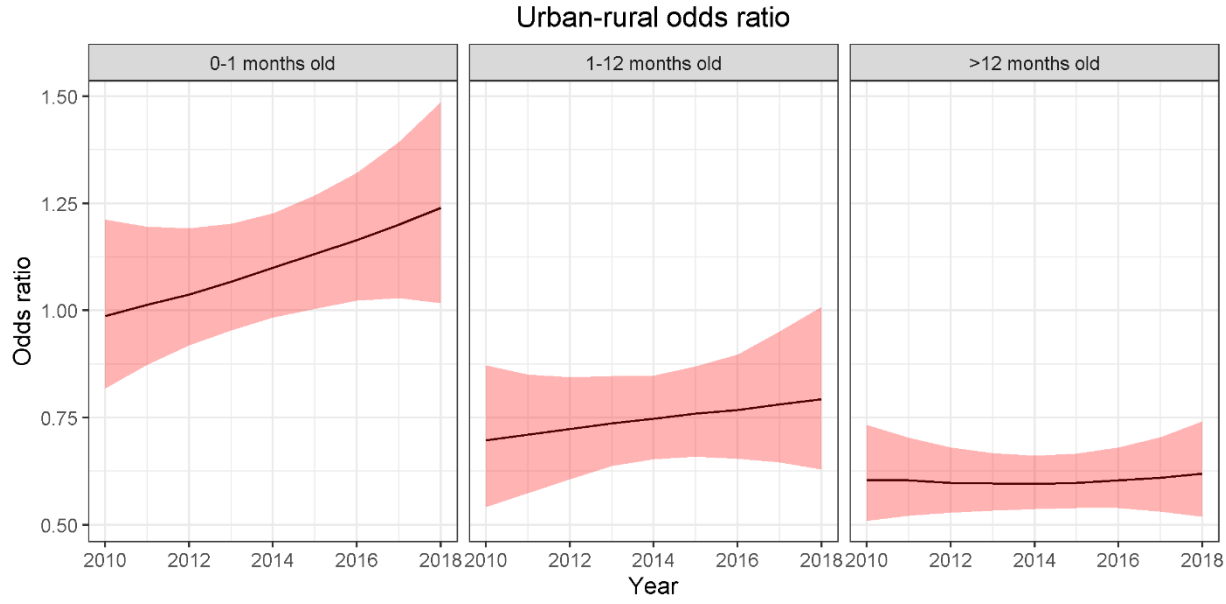


Figure H.5 Nigeria Admin 1 U5MR estimates for 2010-2018

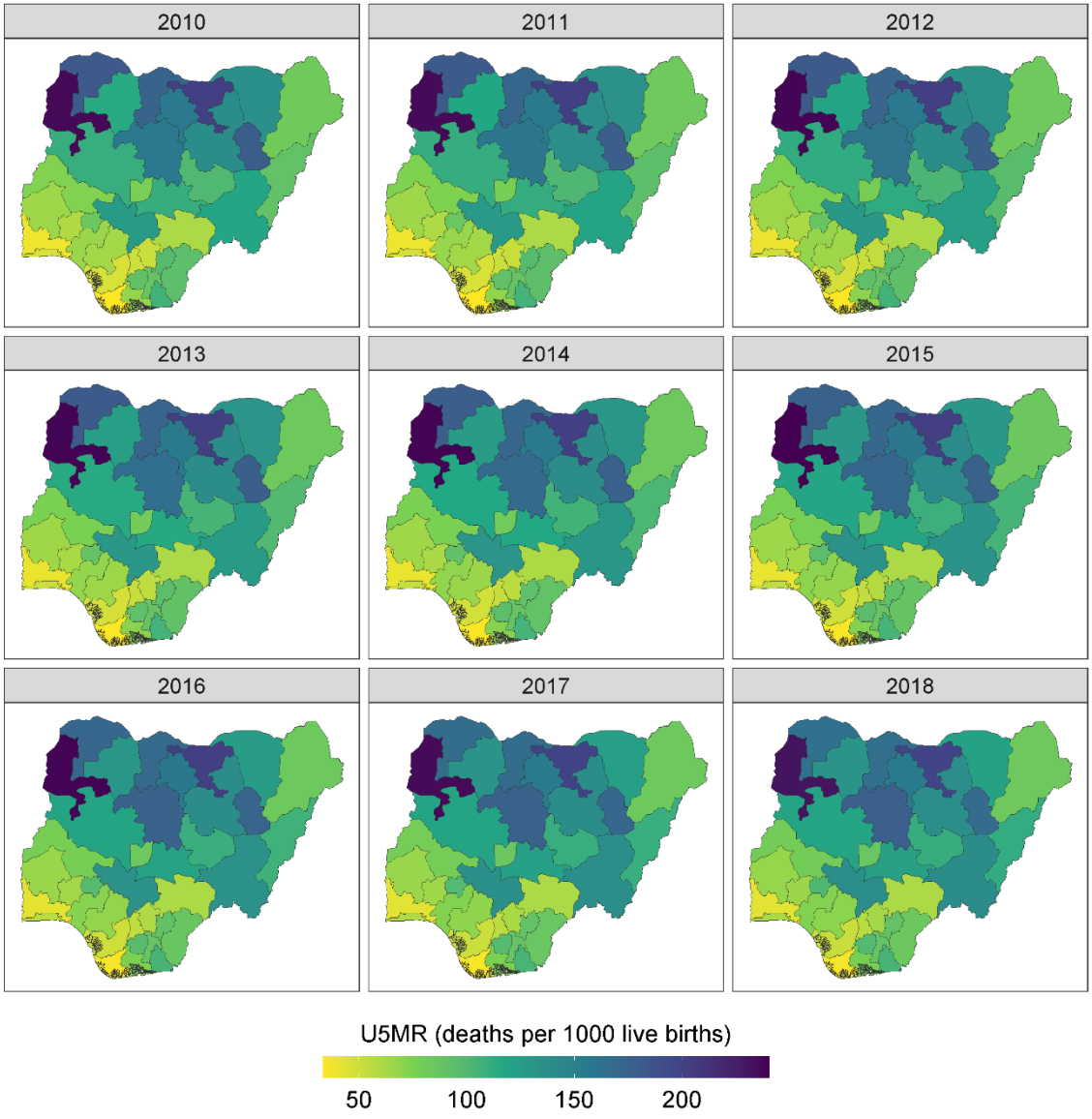


Figure H.6 Nigeria Admin 1 U5MR 95% credible interval width for 2010-2018

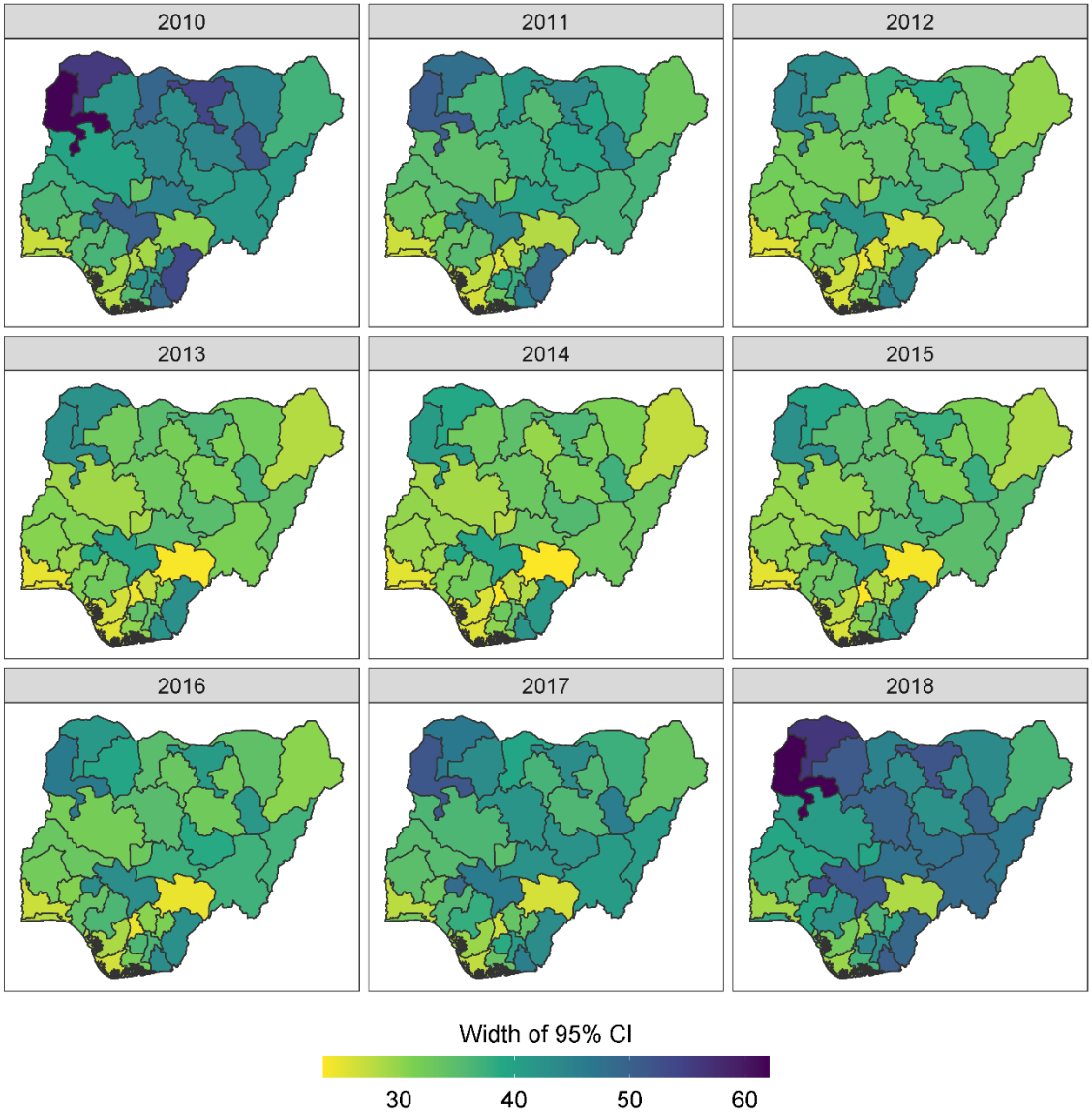


Figure H.7 Nigeria Admin 1 U5MR estimates by year with associated 95% credible intervals for 2010-2018

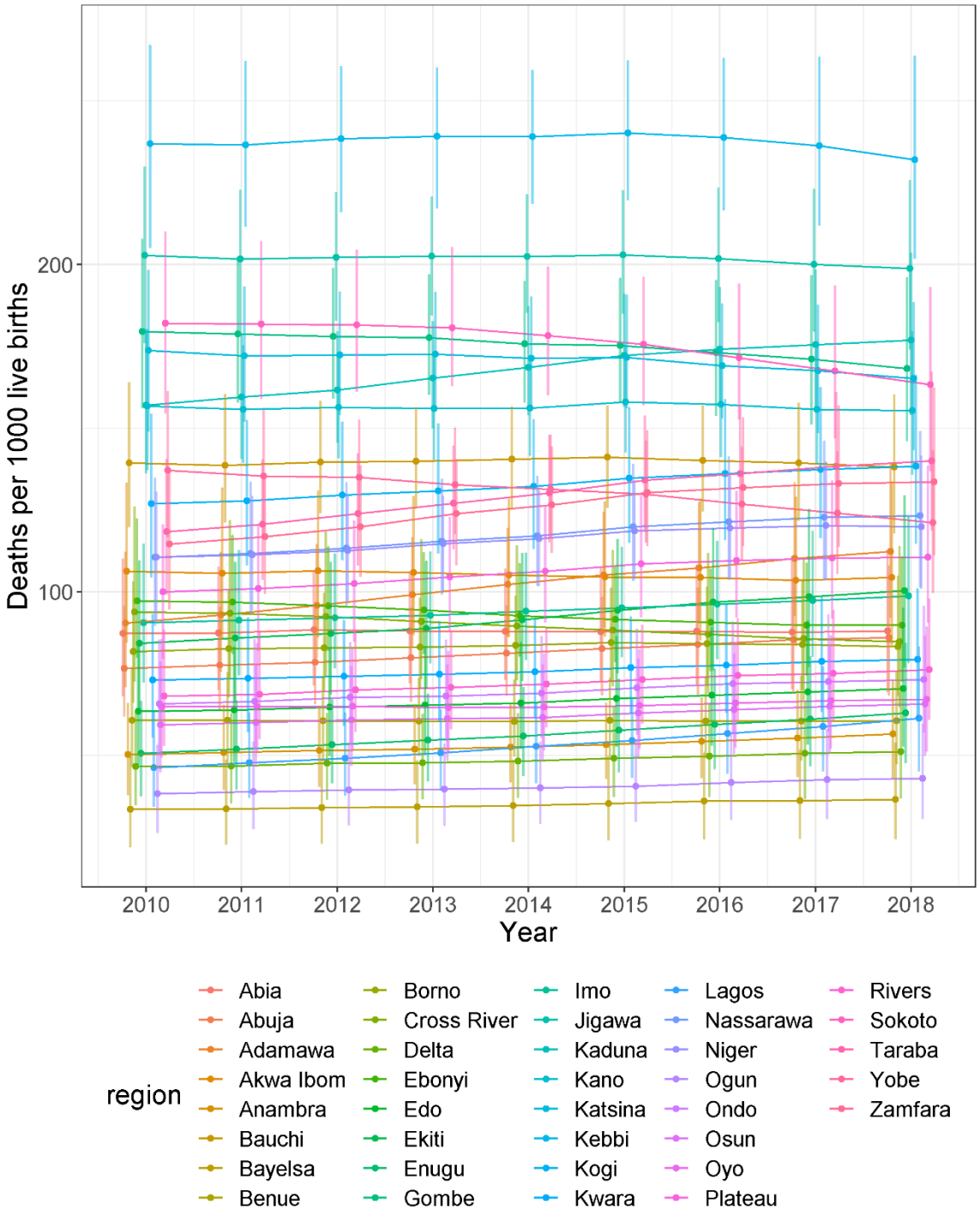


Figure H.8 Nigeria Admin 2 U5MR estimates for 2010-2018

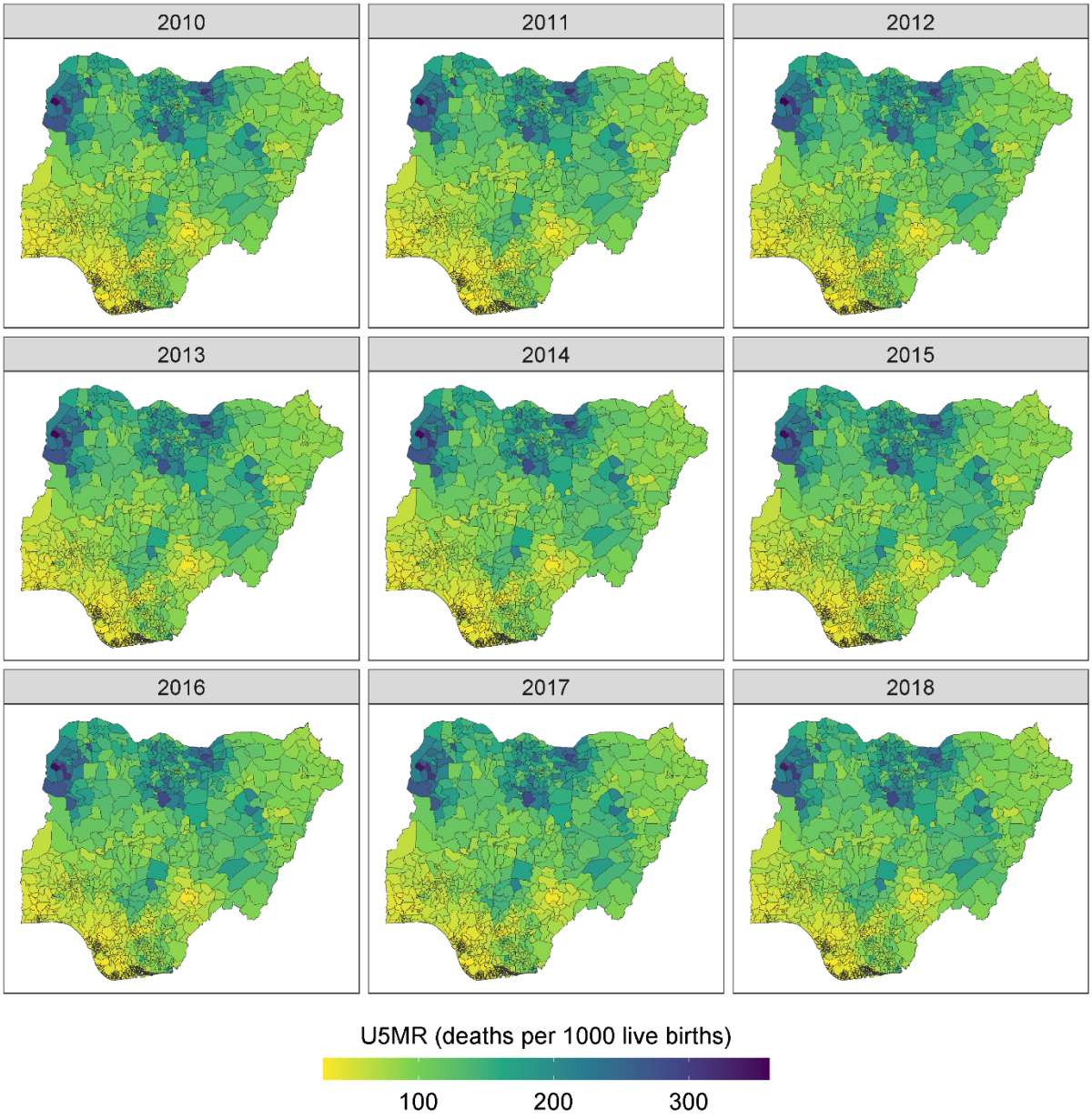


Figure H.9 Nigeria Admin 2 U5MR 95% credible interval width for 2010-2018

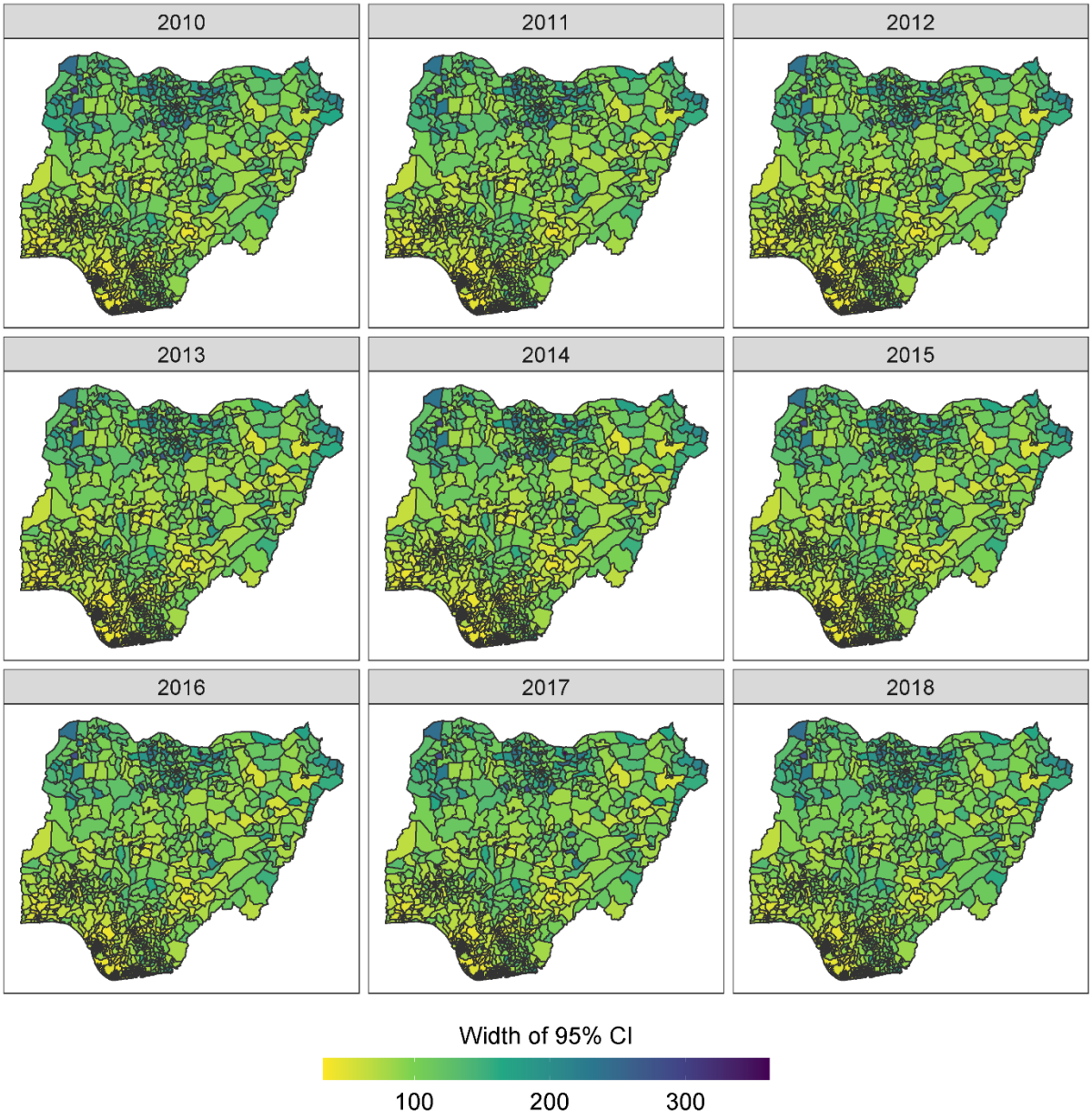


Figure H.10 Nigeria Admin 2 U5MR estimates by year for 2010-2018

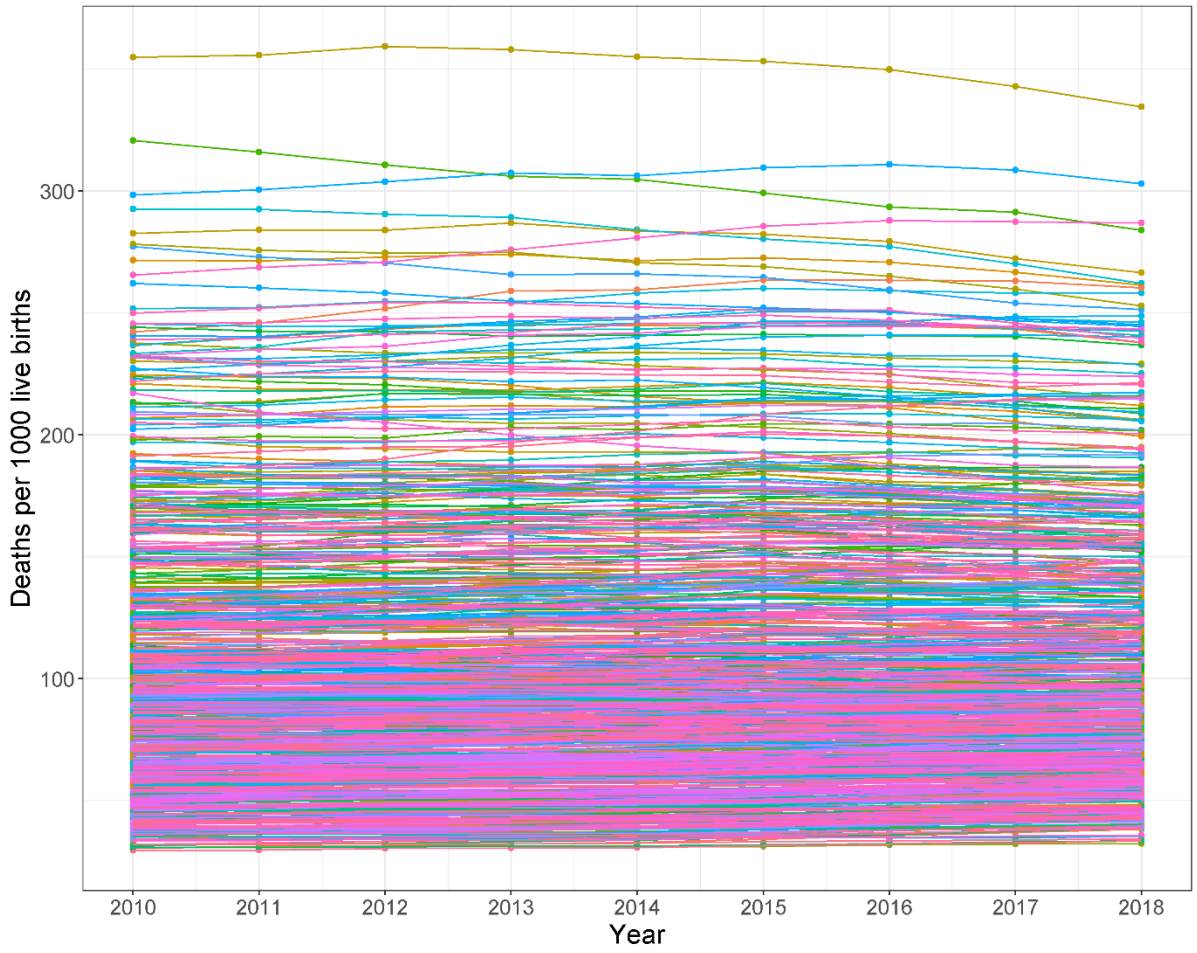


Figure H.11 Ridgeplot representation of posterior distribution of Admin 2 U5MR for Nigeria in 2018. On the top we show the regions with the lowest posterior median U5MR, and on the bottom those with the highest U5MR.

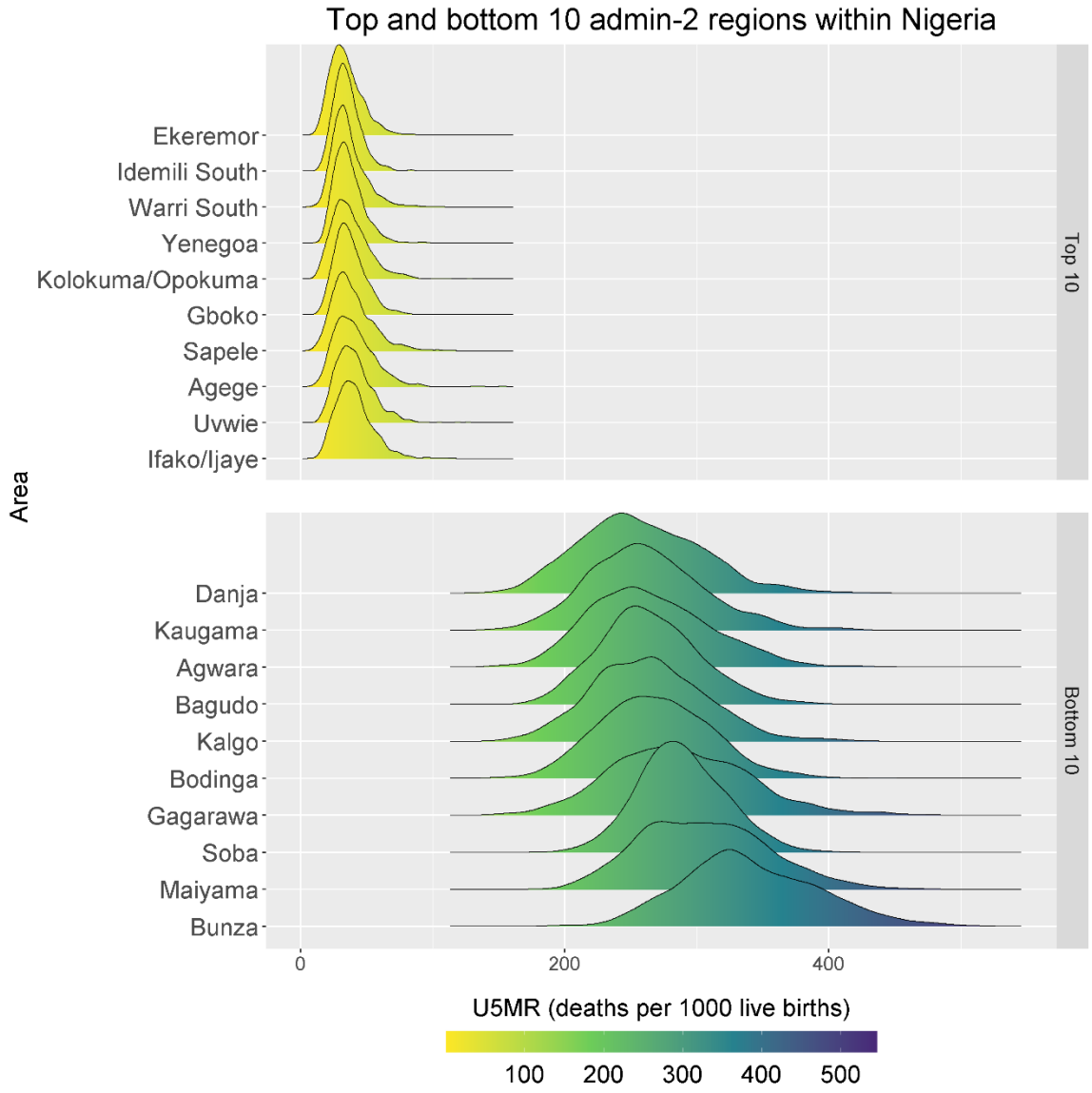


Figure H.12 Estimated Admin 2 U5MR ranking for Nigeria in 2018. On the left we show the regions with the highest U5MR, and on the right those with the lowest U5MR. The expected ranking (ER) of each area is also given.

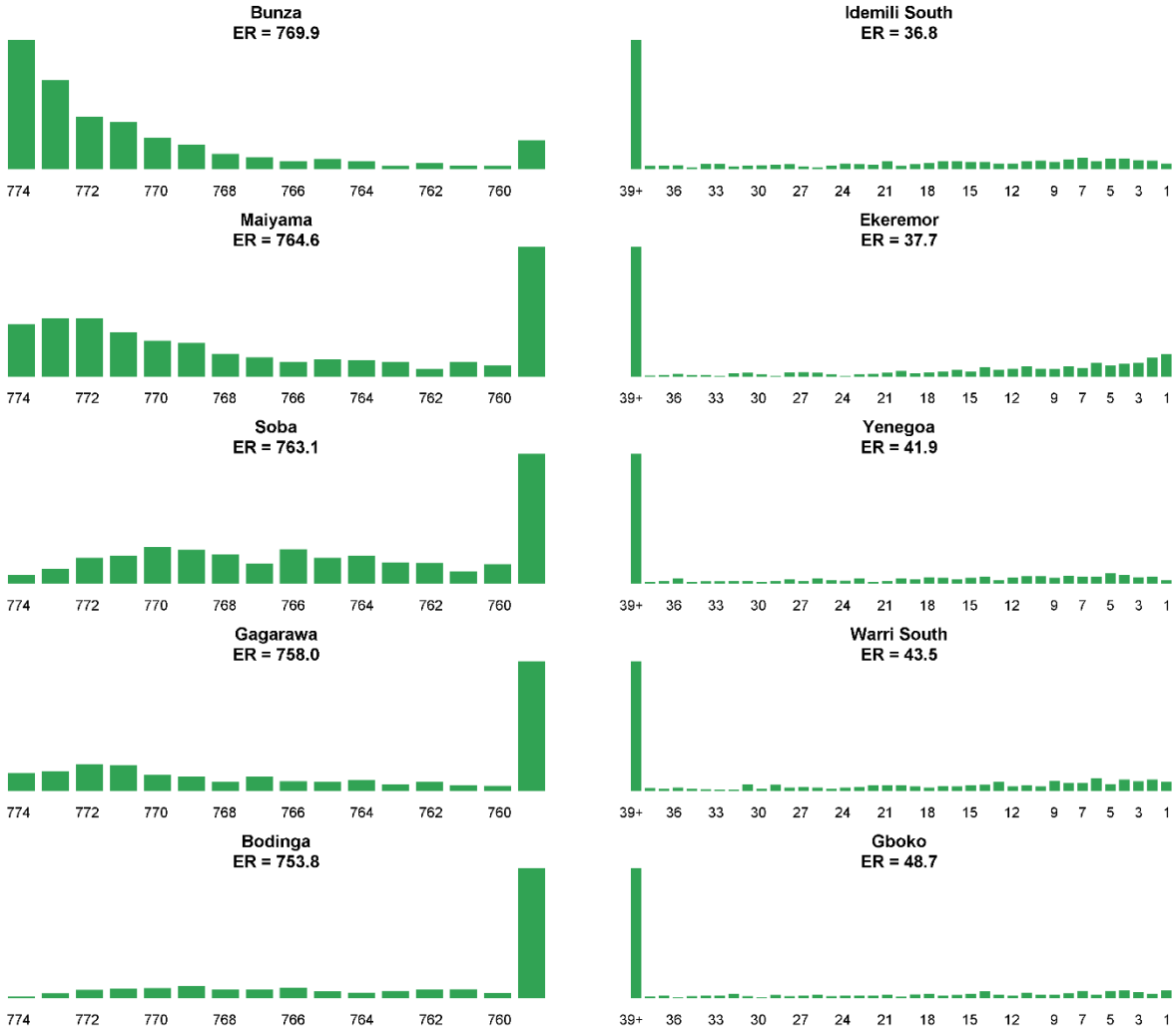
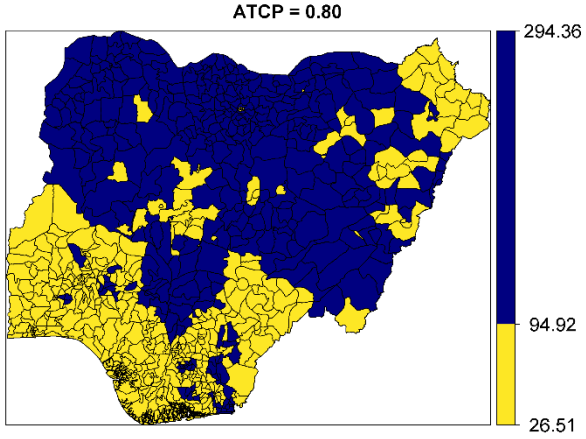
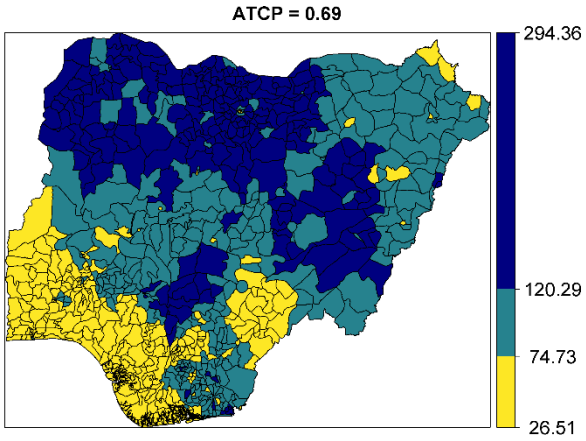


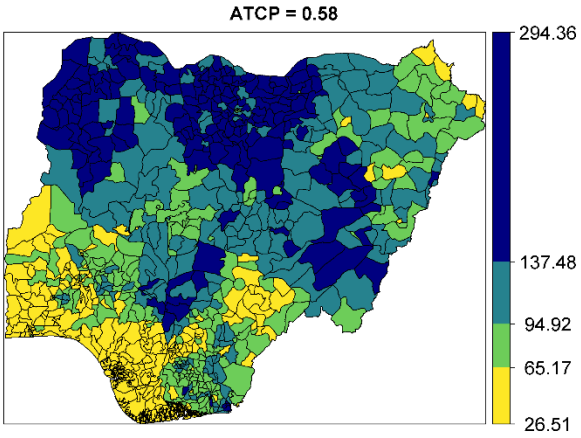
Figure H.13 Average True Classification Probabilities (ATCP) for K = 2, 3, 4 for Nigeria in 2018, where K is the number of colors on maps



(a) $K = 2$



(b) $K = 3$



(c) $K = 4$

APPENDIX I CONTINUOUS SPATIAL MODELS

Although we do not implement any continuous spatial model in this work, we describe how continuous spatial models can be applied to Admin 2 level SAE in this section. We frame the discussion in a spatial setting as all issues extend directly to the spatio-temporal case. A key component of recent works on subnational estimation of U5MR (Golding et al. 2017; Burstein et al. 2019; Wakefield et al. 2019) has been to produce fine-scale spatio-temporal maps. This has motivated model-based geostatistics (MBG) models that can capture fine-scale variation in continuous space through a combination of a spatially varying Gaussian process (GP) and spatially varying covariates. More specifically, equation (10) in the main report is modified so that a spatial effect $S(s_{ic})$ is assigned a zero-mean GP model, and the covariate effect is made spatial, $x(s_{ic})^T\beta$. Such GP models are popular due to their ease of use and are ubiquitous in many scientific disciplines (Diggle et al. 2003; Cressie and Wikle 2011). A detailed introduction in the context of global health can be found in Diggle and Giorgi (2019).

Zero-mean GPs are fully specified through their mean and covariance functions. The most common choice for the covariance function is the Matérn covariance function (Stein 1999), which provides three parameters: the marginal variance σ_s^2, the spatial range ρ_s, and the smoothness ν_s. For specific values of these parameters, $Var[S(s_{ic})] \equiv \sigma_s^2$, the correlation is approximately equal to 0.1 at locations with a distance of ρ_s, and the process itself can be differentiated ceil(ν) times (so if $\nu_s = 1.5$, the process is one time differentiable). Slight variations in the parametrization of Matérn covariance functions are possible, although we follow Lindgren et al. (2011),

$$Cov\big(S(s_1), S(s_2)\big) = \sigma_s^2 \frac{2^{1-\nu_s}}{\Gamma(\nu_s)} \left(\sqrt{8\nu_s} \frac{\| s_2 - s_1 \|}{\rho_s}\right) \mathrm{K}_{\nu_s} \left(\sqrt{8\nu_s} \frac{\| s_2 - s_1 \|}{\rho_s}\right), \qquad s_1, s_2 \in \mathbb{R}^2$$

where Γ is the gamma function, and K_{ν_s} is the modified Bessel function of the second kind, order ν_s.

A straightforward implementation of MBG models is computationally infeasible when the number of clusters $C = \sum_{i=1}^{m} C_i$ is large, and we need to manipulate $C \times C$ matrices that involves $\mathcal{O}(C^3)$ operations (Rue and Held 2005). Various approximations have been proposed to overcome this problem, such as the stochastic partial differential equations (SPDE) approach pioneered by Lindgren et al. (2011), which is implemented in INLA (Rue et al. 2009; Lindgren and Rue 2015). This approach has seen wide adoption in a range of applications and scientific fields (Bakka et al. 2018). When using the SPDE approach with INLA, the smoothness is typically fixed at $\nu_s = 1$ for computational reasons. Template model builder (TMB) lacks the fully Bayesian inference provided by INLA because it does not account for uncertainty in the parameters when generating predictions, although it has the advantage that it allows for more flexible models (Kristensen 2014; Osgood-Zimmerman and Wakefield 2020). There is a wide range of other ways to make MBG models computationally feasible (Heaton et al. 2018), but current implementations do not support general models such as INLA and TMB.

Within Admin 2, spatial variation suggests a continuous-space approach if we need to capture this variation. There are two reasons why we favor models with discrete spatial variation as presented in Section 3. With continuous spatial variation, aggregation to Admin 2 estimates requires auxiliary population information that is imprecise at a continuous spatial scale, which is the $q(s)$ in equation (22) of the main report.

In a simulation study, Paige et al. (2020) found that discrete spatial models worked well with far less hand-tuning than necessary for continuous-space models. Corral et al. (2021) suggest that including random effects at the target level is a better approach than including random effects at finer levels and then aggregating. The direct and smoothed direct approaches avoid the need for auxiliary population information since the weights implicitly encode population information from the original sampling frame. One advantage of continuous spatial models is that they allow data with different spatial information (such as data aggregated over different areal units, or cluster data in which the exact location of the clusters is unknown) to be coherently included, since one can base all calculations on the underlying spatial field (Wilson and Wakefield 2020, 2021).

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