

Côte d'Ivoire: Developing subnational estimates of HIV prevalence and the number of people living with HIV

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▶ **To cite this version:**

Joseph Larmarange. Côte d'Ivoire: Developing subnational estimates of HIV prevalence and the number of people living with HIV. JC2665E, Unaids. 2014, pp.21. ird-03897916

HAL Id: ird-03897916
https://ird.hal.science/ird-03897916

Submitted on 14 Dec 2022

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CÔTE D'IVOIRE

DEVELOPING SUBNATIONAL ESTIMATES OF HIV PREVALENCE AND THE NUMBER OF PEOPLE LIVING WITH HIV

UNAIDS / JC2665E (English original, September 2014)

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METHODOLOGY NOTE

Developing subnational estimates of HIV prevalence and the number of people living with HIV from survey data

Introduction

Significant geographic variation in HIV incidence and prevalence, as well as programme implementation, has been observed between and within countries. Methods to generate subnational estimates of HIV prevalence and the number of people living with HIV are being explored in response to the urgent need for data at smaller administrative units, in order to inform programming that is aligned with local community needs.

This guidance note describes existing methods to generate subnational estimates of HIV prevalence and the number of people living with HIV from survey data, with a particular focus on the development of maps of estimates at second administrative level through the prevR model *(1)* as a data visualization resource. Although HIV estimates at the first administrative level can be generated through various methods and sources for countries with available data, HIV estimates at the second administrative level are not currently available. Estimates at the second administrative level generated through prevR must be interpreted with caution; however, they provide an indication of the status of the epidemic subnationally within a country. A more complex method for estimating HIV prevalence and other variables at the second administrative level is being further developed, which will be integrated with existing Joint United Nations Programme on HIV/AIDS (UNAIDS) estimation processes.

prevR

Applying the prevR method to generate maps of estimates of the number of people living with HIV (aged 15–49 and 15 and older) and of HIV prevalence (aged 15–49) at the second administrative level was recommended by participants at a technical consultation on methods for generating subnational estimates. This consultation, held in Nairobi, Kenya, 24–25 March 2014, was convened by the HIV Modelling Consortium, the UNAIDS Reference Group on Estimates, Modelling and Projections and the UNAIDS Task Force on Hotspots. It served as a follow-up to the July 2013 consultation on identifying populations at greatest risk of infection, which focused on geographic hotspots and key populations.

The countries to which this method was applied were selected based on the availability of data from Demographic and Health Surveys (DHS) or AIDS Indicator Surveys (AIS), which included georeferenced and HIV testing data gathered since 2009. Beginning in 2009, the displacement of DHS cluster data[1] was restricted to the second administrative level *(2)*.

1. In DHS surveys, clusters (groupings of households) are georeferenced, with a random displacement of latitude and longitude. Urban clusters are displaced by a maximum of 2 km and rural clusters by a maximum of 5 km, with 1% displaced 10km. Please see reference 2 for details. Displacement is restricted to within a country and to survey regions, and, since 2009, has also been restricted to the second administrative level, where possible.

Method

The survey data have been spatially distributed using a kernel density approach with adaptive bandwidths based on a minimum number of observations in order to generate estimates of HIV prevalence among people aged 15–49 years. This method was described in detail elsewhere *(1)* and was implemented in the prevR package (in R language).

The basic principle of the prevR method is to calculate an intensity surface of positive cases and an intensity surface of observations. The ratio of positive cases to observations results in the prevalence surface.

The intensity surface of observations is expressed as the number of observations per surface area (per square degree or per square km, depending on the coordinate system). The volume below this surface is equal to the total number of observations in the dataset. This surface indicates how observations are distributed from a scatterplot on a continuous surface.

For each administrative unit, the integral of the intensity surface is calculated (i.e. the corresponding volume below this surface) to obtain the number of distributed observations in that administrative unit.

Results are merged per administrative unit and uncertainty bounds are calculated as 95% confidence intervals based on the distributed number of observations (through kernel density estimations) per unit. This confidence interval is wider in less-surveyed areas and narrower in areas with several survey clusters.

The spatial distribution of the population is based on LandScan, which is used to generate the spatial distribution of the population aged 15 to 49 and the population aged 50 and over, adjusted to estimates of the total population aged 15 to 49 and 15 and older from Spectrum.[2]

The spatial distribution of HIV prevalence and people living with HIV was estimated using prevR and DHS data. Prevalence among the population 50 years and older was computed using a prevalence ratio derived from UNAIDS estimates produced using Spectrum software *(3)*.

Finally, estimates were adjusted to UNAIDS estimates of the number of people living with HIV aged 15–49 and 15 and older *(3)*. National estimates obtained by aggregating subnational estimates of the number of people living with HIV and HIV prevalence generated using this method will, therefore, match UNAIDS estimates.

UNAIDS estimates are midyear estimates. For countries with a DHS conducted during a single year, the estimates are adjusted to the same year. For countries with DHS conducted over two years, estimates are adjusted to UNAIDS estimates for the second year of the survey.

2. Population estimates were obtained through the Spectrum module DemProj. These estimates are based on the United Nations Population Division's World Population Prospects 2012. Some differences may exist between the United Nations Population Division estimates and those obtained through Spectrum. United Nations Population Division estimates are input into Spectrum, and are then adjusted within Spectrum by removing the estimated population of people living with HIV, which is then added back through the estimation process. This process is limited to the 39 high-burden countries.

The main hypotheses of this method are as follows:

- The age structure are uniform across the country.
- Population-based survey data is used only to define the shape of the prevalence surface, while the level of prevalence is defined by UNAIDS estimates.
- The spatial distribution of HIV among people aged 50 and over is equal to the spatial distribution of HIV among people aged 15 to 49.

Quality of the subnational estimates of HIV prevalence and number of people living with HIV generated through prevR

Subnational estimates are accompanied by a quality of estimates indicator and 95% confidence intervals. The estimate quality is categorized based on the following scale:

- Good: estimates are based on observations from the same subnational area.
- Moderately good: estimates are primarily based on observations from the same subnational area.
- Uncertain: estimates are primarily based on observations from a neighbouring subnational area.
- Very uncertain: estimates are based only on observations from a neighbouring subnational area.

The quality of HIV estimates at the subnational level depends on the survey sample size. DHS was designed to be representative at the national and first administrative levels, but, in most countries, not at the second administrative level beyond the DHS regions. The number of observations per subnational area varies significantly. If some subnational areas have been sufficiently surveyed, others may be underrepresented. In that case, HIV prevalence has been estimated using observations from neighbouring areas and is categorized as uncertain or very uncertain. Uncertainty estimates correspond to variations between first administrative level areas and may be inaccurate when local variations are not captured by the survey. Sources of administrative area boundaries used to determine if an observation crossed over a second-level administrative border may have errors, therefore observations near border areas need to be considered as uncertain as to their location.

Areas with a higher relative HIV prevalence (expressed as a percentage) are not necessarily those with a higher absolute number of people living with HIV (represented on the people living with HIV density map) since the spatial distribution of the population is highly irregular.

Confidence intervals complement the quality of estimates indicator. Confidence intervals only take into account that estimates of the prevalence and the number of people living with HIV aged 15–49 are based on a limited number of observations. They do not consider the spatial dimension of the estimates.

How are subnational estimates of HIV prevalence and number of people living with HIV produced using prevR related to the UNAIDS estimation process using Spectrum?

UNAIDS estimates trends of HIV prevalence over time at the national level using multiple data sources including population-based surveys. This report estimates spatial subnational variations of HIV prevalence and the number of people living with HIV for a given year based on a unique population-based survey. Furthermore, the spatial distribution of observations is taken into account here. These two approaches should be considered complementary.

Data sources

The following data were used:

- DHS/AIS (http://www.dhsprogram.com/):
  - Burkina Faso, DHS, 2010,
  - Burundi, DHS, 2010,
  - Cameroon, DHS, 2011,
  - Côte d'Ivoire, DHS, 2011–2012,
  - Ethiopia, DHS, 2011,
  - Gabon, DHS, 2012,
  - Guinea, DHS-Multiple Indicator Cluster Survey (MICS), 2012,
  - Haiti, DHS, 2012,
  - Lesotho, DHS, 2009,
  - Malawi, DHS, 2010,
  - Mozambique, DHS, 2009,
  - Rwanda, DHS, 2010–2011,
  - Senegal, DHS-MICS, 2010–2011,
  - Sierra Leone, DHS, 2008,
  - United Republic of Tanzania, Tanzania HIV/AIDS and Malaria Indicator Survey (THMIS), 2011–2012,
  - Uganda, AIS, 2011 and
  - Zimbabwe, DHS, 2010–2011;

- LandScan for the global population distribution (http://web.ornl.gov/sci/landscan/);

- Administrative boundaries:
  - Global Administration Areas (GADM) (http://www.gadm.org/)
  - Rwanda, the National Statistics Institute of Rwanda (http://statistics.gov.rw/geodata);
  - Gabon and Uganda, Global Administrative Unit Layers (GAUL) (http://www.fao.org/geonetwork/srv/en/metadata.show?id=12691)

- Background layers:
  - Google Maps API (https://www.google.com/maps)
  - OpenStreetMap (http://www.openstreetmap.org/); and

- UNAIDS 2013 HIV estimates.

Other methods for generating subnational HIV estimates

From DHS

HIV testing has been conducted by DHS since 2001, on the basis of which nationally representative estimates of HIV prevalence are produced. Estimates of HIV prevalence at the first administrative level are also produced. DHS is typically designed to be representative at the national and first administrative levels, but not at the subnational level more specific than the first administrative level. Prevalence estimates from DHS for countries that have included HIV testing in their surveys are available from the DHS website (https://dhsprogram.com/) through StatCompiler or through country reports or datasets.

Spectrum/Estimation and Projection Package (EPP)

Estimates for countries and first administrative level are generated using Spectrum/Estimation and Projection Package (EPP) based on the data available. Data sources include surveys of pregnant women attending antenatal clinics, population-based surveys, sentinel surveillance among key populations at higher risk, case reporting, programme data on antiretroviral therapy and prevention of mother-to-child transmission programmes and demographic data. The results from these models include a wide array of variables related to HIV including HIV prevalence and number of people living with HIV.

Annually, UNAIDS and its partners support country-level teams in producing national estimates using Spectrum. Every two years, UNAIDS and its partners conduct regional workshops to train national personnel on the tools and methodologies used to produce national estimates. Country-level teams are then responsible for calculating HIV estimates and projections. Regional estimates are produced separately for each region based on data only from that province *(4)*.
In several countries where data are available, including India, South Africa, Nigeria, Mozambique and Kenya, estimates have been produced at the regional level using Spectrum.

In Kenya for example, estimates were first produced at the provincial level[3] applying Spectrum/EPP by including province-level inputs. In the next step, the provincial-level estimates were disaggregated to the county level. Population projections for each province were based on the total fertility rates and mortality indicators from the Kenya DHS and adjusted to match the estimates from the national census. Population estimates for counties were taken from the National Bureau of Statistics. For each county, the prevalence was determined by examining surveillance and survey cluster data from 2003 to 2012. As stated in the report:

The prevalence estimate for 2013 for each county was multiplied by the population aged 15–49 in the county to estimate the number of [HIV-positive] adults. The number of [HIV-positive] adults in each county was adjusted so that the total across all counties in a province would equal the provincial total. Values for other indicators were first distributed by county according to the number of [HIV-positive] adults and then adjusted to match the provincial totals *(5)*.

3. Note that while the DHS/AIS were designed to inform at the level of the province, the provincial administrative level is no longer in existence in Kenya.

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1. Larmarange J, Vallo R, Yaro S, Msellati P, Méda N. Methods for mapping regional trends of HIV prevalence from Demographic and Health Surveys (DHS). CyberGeo: European Journal of Geography. 2011;558. doi:10.4000/cybergeo.24606.

2. Burgert, Clara R., Josh Colston, Thea Roy, and Blake Zachary. 2013. Geographic displacement procedure and georeferenced data release policy for the Demographic and Health Surveys. DHS Spatial Analysis Reports No. 7. Calverton, Maryland, USA: ICF International.

3. Methodology – understanding the HIV estimates. Geneva: Joint United Nations Programme on HIV/AIDS; 2013 (http://www.unaids.org/en/media/unaids/contentassets/documents/epidemiology/2013/gr2013/20131118_Methodology.pdf, accessed 7 July 2014).

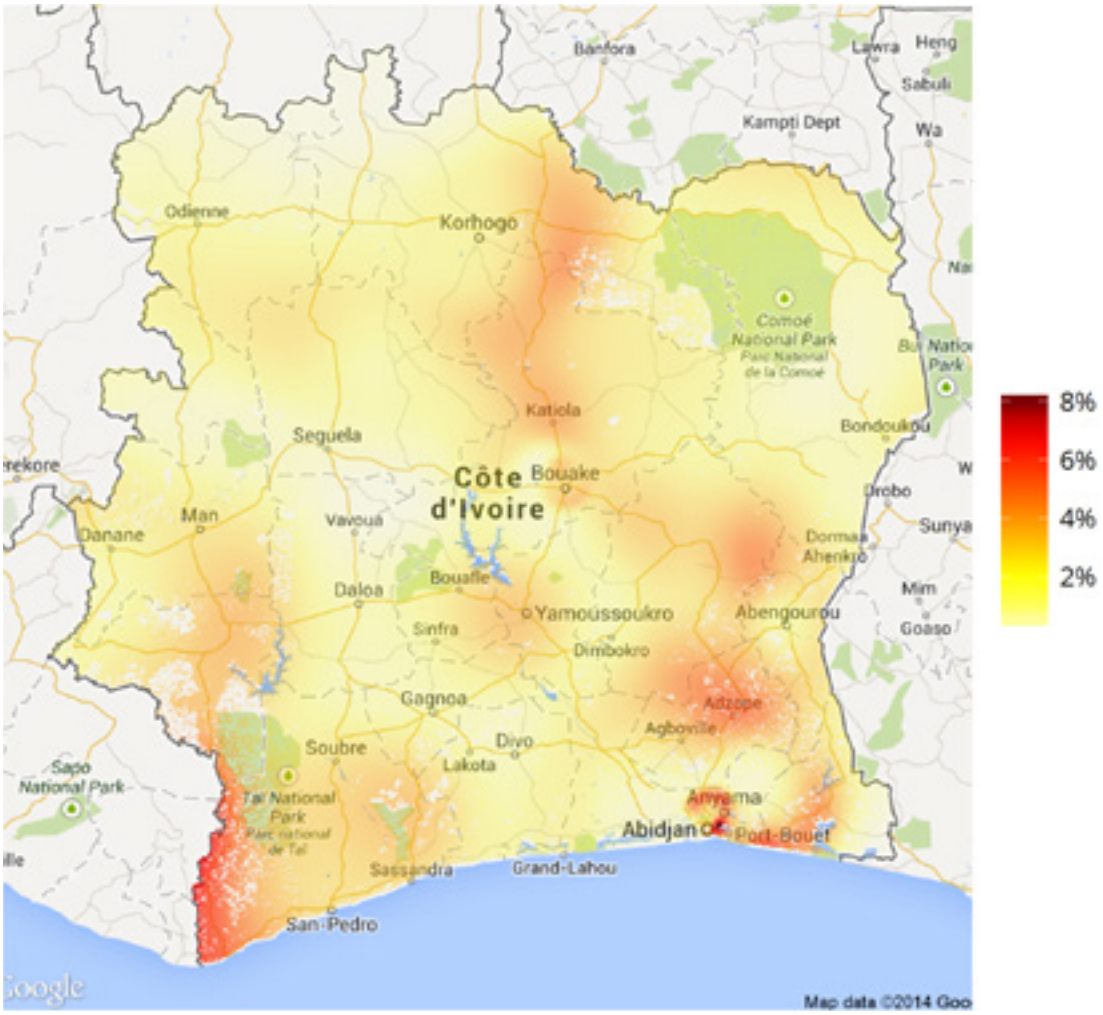
4. Stover J, Brown T, Marston M. Updates to the Spectrum/Estimation and Projection Package (EPP) model to estimate HIV trends for adults and children. Sexually Transmitted Infections. 2012;88(Suppl 2):i11–.i16. doi:10.1136/sextrans-2012-050640.

5. National HIV indicators for Kenya: 2013. National AIDS and STI Control Programme; 2013.

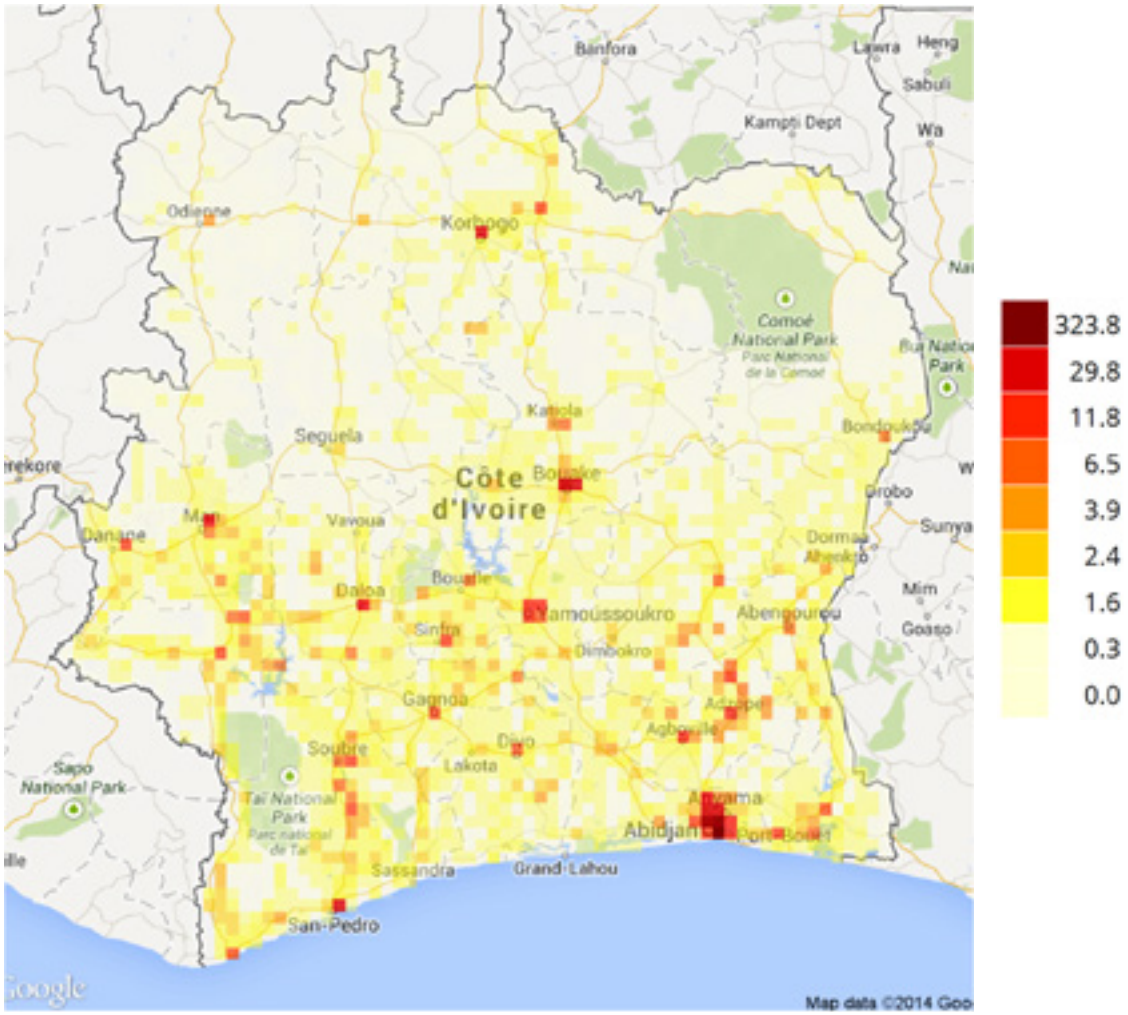
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HIV estimates at department level

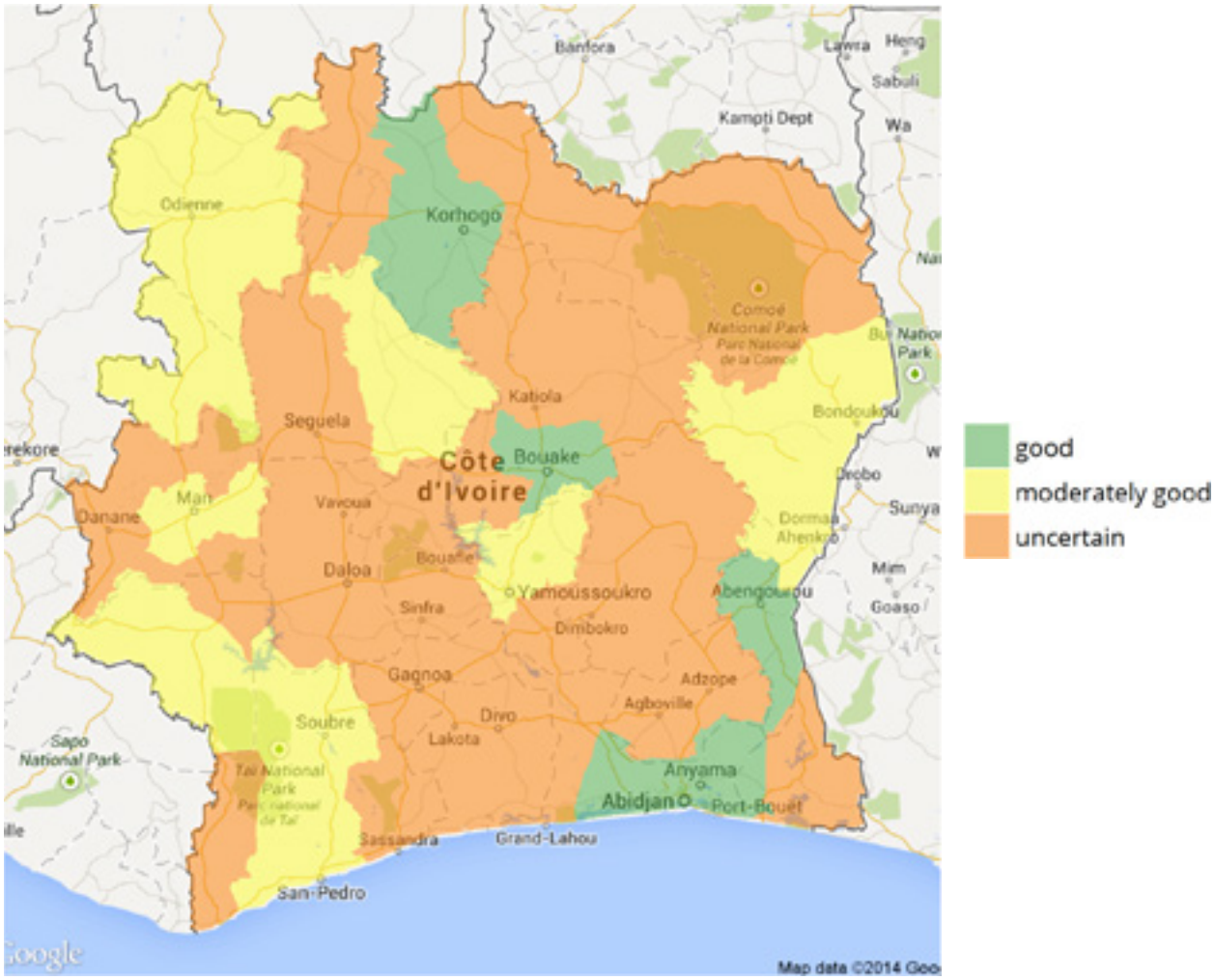
HIV prevalence (15-49 years old)

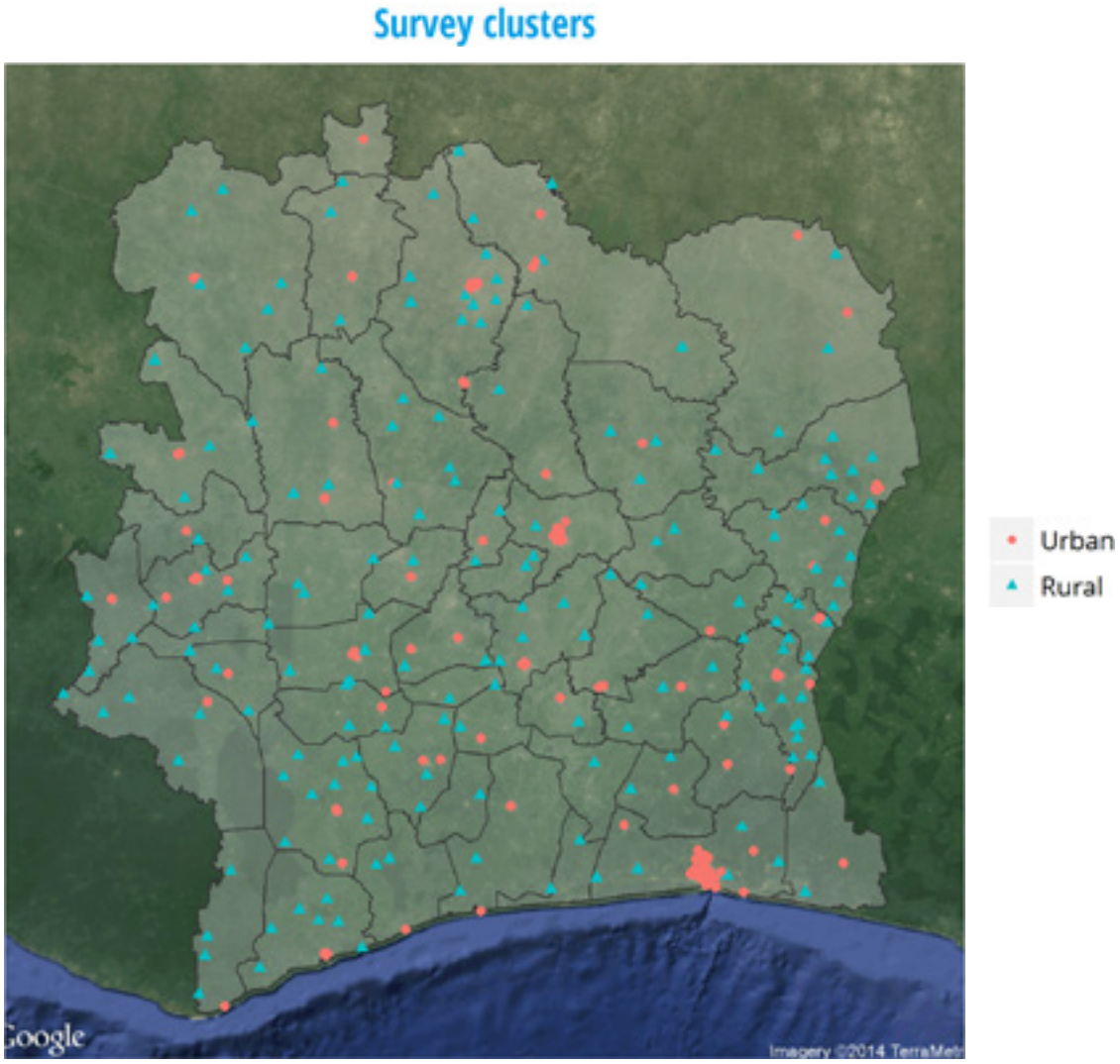


People living with HIV density (15+ years old, PLWHIV/km²)



Quality of estimates





Quality of estimates

- *Good:* estimates are based on observations from the same department.
- *Moderately good:* estimates are mainly based on observations from the same department.
- *Uncertain:* estimates are mainly based on observations from neighboring departments.
- *Very uncertain:* estimates are based only on observations from neighboring departments.

Quality of HIV estimates at department level depends on the sampling size of the 2011/12 Cote d'Ivoire DHS-MICS survey, where a total of 8 817 individuals (15-49 years old) were tested successfully for HIV in 339 survey clusters with geolocation.

Estimates per department

Region / Province	HIV prevalence (15-49 years old)	People living with HIV (15-49 years old)	People living with HIV (15+ years old)	Quality of estimates
Agnéby				
Adzopé	4,70%	8 000	9 300	uncertain
Agboville	3,10%	4 600	5 400	uncertain
Bafing				
Touba	1,60%	1 400	1 600	moderately good
Bas-Sassandra				
San-Pédro	3,30%	8 600	10 000	moderately good
Sassandra	3,50%	3 900	4 500	uncertain
Soubré	2,80%	11 000	12 000	moderately good
Tabou	5,70%	4 900	5 700	uncertain
Denguélé				
Odienné	1,70%	2 300	2 700	moderately good
Dix-Huit Montagnes				
Bangolo	3,30%	2 600	3 000	uncertain
Biankouma	2,00%	1 500	1 700	uncertain
Danané	2,10%	4 000	4 700	uncertain
Man	2,80%	6 200	7 200	moderately good
Fromager				
Gagnoa	2,00%	4 300	5 000	uncertain
Oumé	2,50%	2 700	3 100	uncertain
Haut-Sassandra				
Daloa	1,90%	5 900	6 900	uncertain
Issia	1,90%	3 100	3 600	uncertain
Vavoua	1,30%	2 300	2 700	uncertain
Lacs				
Toumodi	2,60%	1 600	1 900	uncertain
Yamoussoukro	3,10%	6 900	8 000	moderately good
Lagunes				
Abidjan	3,60%	79 000	92 000	good
Grand-Lahou	2,20%	1 100	1 200	uncertain
Tiassalé	2,60%	3 000	3 500	uncertain

Region / Province	HIV prevalence (15-49 years old)	People living with HIV (15-49 years old)	People living with HIV (15+ years old)	Quality of estimates
Marahoué				
Bouaflé	2,50%	3 600	4 200	uncertain
Sinfra	2,50%	2 600	3 100	uncertain
Zuénoula	1,10%	1 100	1 300	uncertain
Moyen-Cavally				
Duékoué	3,80%	4 700	5 500	uncertain
Guiglo	3,20%	6 000	6 900	moderately good
Moyen-Comoé				
Abengourou	2,70%	4 800	5 500	good
Agnibilékrou	3,20%	2 100	2 400	moderately good
N'zi-Comoé				
Bongouanou	3,30%	4 900	5 700	uncertain
Daoukro	3,80%	2 600	3 100	uncertain
Dimbokro	2,30%	2 300	2 700	uncertain
Mbahiakro	3,00%	2 000	2 300	uncertain
Savanes				
Boundiali	1,40%	1 400	1 600	uncertain
Ferkessédougou	2,90%	4 300	5 000	uncertain
Korhogo	2,30%	6 400	7 400	good
Tengréla	0,60%	220	250	uncertain
Sud-Bandama				
Divo	2,00%	6 600	7 700	uncertain
Lakota	2,00%	1 800	2 000	uncertain
Sud-Comoé				
Aboisso	3,20%	6 000	6 900	uncertain
Vallée du Bandama				
Béoumi	2,50%	1 600	1 800	uncertain
Bouaké	3,10%	12 000	13 000	good
Dabakala	2,50%	1 600	1 800	uncertain
Katiola	4,00%	4 100	4 700	uncertain
Sakassou	1,70%	840	970	uncertain
Worodougou				
Mankono	2,10%	2 700	3 200	moderately good
Séguéla	1,80%	1 900	2 200	uncertain

Region / Province	HIV prevalence (15-49 years old)	People living with HIV (15-49 years old)	People living with HIV (15+ years old)	Quality of estimates
Zanzan				
Bondoukou	1,70%	3 100	3 600	moderately good
Bouna	2,00%	2 100	2 500	uncertain
Tanda	2,10%	2 800	3 200	moderately good
ALL	**2,80%**	**260 000**	**310 000**	

Uncertainty bounds

Region / Province	HIV prevalence (15-49 years old)		People living with HIV (15-49 years old)		Quality of estimates
	Low	High	Low	High	
Agnéby					
Adzopé	1,90%	10,20%	3 300	18 000	uncertain
Agboville	0,50%	12,80%	680	19 000	uncertain
Bafing					
Touba	0,20%	6,80%	210	5 800	moderately good
Bas-Sassandra					
San-Pédro	1,20%	8,10%	3 100	21 000	moderately good
Sassandra	0,90%	10,60%	1 000	12 000	uncertain
Soubré	1,10%	6,30%	4 300	24 000	moderately good
Tabou	1,70%	15,50%	1 500	13 000	uncertain
Denguélé					
Odienné	0,40%	5,30%	570	7 300	moderately good
Dix-Huit Montagnes					
Bangolo	0,70%	10,90%	570	8 800	uncertain
Biankouma	0,30%	7,80%	250	5 700	uncertain
Danané	0,40%	8,20%	690	16 000	uncertain
Man	1,00%	7,00%	2 100	16 000	moderately good
Fromager					
Gagnoa	0,50%	6,20%	1 100	14 000	uncertain
Oumé	0,40%	10,10%	400	11 000	uncertain
Haut-Sassandra					
Daloa	0,50%	5,90%	1 500	19 000	uncertain
Issia	0,40%	6,90%	600	11 000	uncertain
Vavoua	0,20%	5,90%	330	10 000	uncertain
Lacs					
Toumodi	0,50%	9,60%	310	5 900	uncertain
Yamoussoukro	1,30%	6,80%	2 900	15 000	moderately good
Lagunes					
Abidjan	2,70%	4,80%	59 000	110 000	good
Grand-Lahou	0,00%	21,90%	0	11 000	uncertain
Tiassalé	0,30%	12,20%	320	14 000	uncertain

Region / Province	HIV prevalence (15-49 years old)		People living with HIV (15-49 years old)		Quality of estimates
	Low	High	Low	High	
Marahoué					
Bouaflé	0,60%	7,60%	950	11 000	uncertain
Sinfra	0,30%	10,90%	350	12 000	uncertain
Zuénoula	0,00%	8,30%	20	8 100	uncertain
Moyen-Cavally					
Duékoué	1,20%	10,50%	1 400	13 000	uncertain
Guiglo	1,40%	6,70%	2 600	13 000	moderately good
Moyen-Comoé					
Abengourou	1,50%	4,70%	2 700	8 300	good
Agnibilékrou	0,90%	9,10%	610	6 000	moderately good
N'zi-Comoé					
Bongouanou	1,00%	9,20%	1 500	14 000	uncertain
Daoukro	0,90%	12,40%	600	8 600	uncertain
Dimbokro	0,40%	8,70%	420	8 800	uncertain
Mbahiakro	0,40%	12,40%	270	8 300	uncertain
Savanes					
Boundiali	0,10%	7,80%	100	7 800	uncertain
Ferkessédougou	1,00%	7,20%	1 500	11 000	uncertain
Korhogo	1,20%	4,40%	3 200	12 000	good
Tengréla	0,00%	33,70%	0	13 000	uncertain
Sud-Bandama					
Divo	0,30%	8,40%	950	28 000	uncertain
Lakota	0,10%	12,30%	90	11 000	uncertain
Sud-Comoé					
Aboisso	0,40%	13,10%	840	25 000	uncertain
Vallée du Bandama					
Béoumi	0,20%	12,70%	140	8 000	uncertain
Bouaké	1,80%	5,10%	6 800	19 000	good
Dabakala	0,40%	10,10%	240	6 400	uncertain
Katiola	1,50%	9,80%	1 500	9 900	uncertain
Sakassou	0,20%	8,80%	80	4 300	uncertain

Region / Province	HIV prevalence (15-49 years old)		People living with HIV (15-49 years old)		Quality of estimates
	Low	High	Low	High	
Worodougou					
Mankono	0,80%	5,00%	1 100	6 400	moderately good
Séguéla	0,50%	5,30%	510	5 600	uncertain
Zanzan					
Bondoukou	0,50%	5,00%	870	9 000	moderately good
Bouna	0,30%	7,80%	360	8 400	uncertain
Tanda	0,80%	5,10%	1 000	6 800	moderately good
ALL	**2,50%**	**3,20%**	**230 000**	**300 000**	

Guidance

Please refer to the methodology note on Developing subnational estimates of HIV prevalence and the number of people living with HIV available on http://www.unaids.org.

Data sources

- DHS-MICS Cote d'Ivoire 2011/12 (http://www.dhsprogram.com/)
- 2013 UNAIDS estimates computed with Spectrum/EPP (http://www.unaids.org/en/dataanalysis/datatools/spectrumepp2013/)
- LandScan 2012 for global population distribution (http://web.ornl.gov/sci/landscan/)
- GADM for administrative boundaries (http://www.gadm.org/)
- Google Maps API for background layers (https://www.google.com/maps)

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