Inferring population dynamics from census data: an evaluation study in three Health and Demographic Surveillance Systems in rural Senegal Bruno Masquelier^{1,2}, Cheikh Tidiane Ndiaye³, Gilles Pison², Ndèye Binta Diémé Coly³, Samba Ndiaye³, Lucie Lecomte⁴, Valérie Delaunay⁴

Background

► In Senegal, censuses remain a a key source for assessing population dynamics, in the absence of a comprehensive system of civil registration and vital statistics.

► To evaluate the quality of census data, we compared key demographic parameters obtained from the 2002 and 2013 Population and Housing Censuses (PHC) with data collected prospectively in three Health and Demographic Surveillance Systems (HDSS):



Localisation of the three HDSS in Bandafassi, Niakhar and Mlomp. Senegal We extracted from censuses all records referring to areas covered by HDSS and we are currently linking individual-level records. Here we compare population sizes, numbers of households and coumpounds, age structures, trends in under-five mortality, and age-specific fertility and mortality rates between sources.

Population age structures



Age profiles are broadly similar in HDSS and in PHC, despite noticeable differences among children aged 5-14 and young adults. A large fraction of temporary migrants considered as long-term residents in HDSS were not enumerated in the censuses conducted during the dry season, because of less inclusive residency rules than in HDSS. In Niakhar and Mlomp, most of these temporary migrants could be removed from the HDSS database (and are not represented here). If censuses had been conducted during the rainy season, the enumerated populations would have been larger with different age structures. The timing of the data collection is a key parameter when analyzing rural-urban differentials from cross-sectional data.

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Population sizes, numbers of households and compounds

Numbers of residents by sex, and numbers of compounds and households are presented below for the three sites at the time of the two censuses, along with ratios of units enumerated in the censuses to those registered in the HDSS.

	Males	Ratio	Females	Ratio	Compounds	Ratio	Households	Ratio
	HDSS	PHC/HDSS	HDSS	PHC/HDSS	HDSS	PHC/HDSS	HDSS	PHC/HDSS
Bandafassi 2002	5458	0.94	5656	0.97	682	1.44		
Bandafassi 2013	6740	0.92	6697	0.93	774	1.59		
Mlomp 2002	2771	0.98	2763	0.95	218	3.12	1211	0.90
Mlomp 2013	3016	0.83	3153	0.79	210	3.78	1301	0.78
Niakhar 2002	15202	0.93	15579	0.96	1928	0.88	3757	0.75
Niakhar 2013	22224	0.83	22534	0.88	2227	0.98	3429	1.05

Even after excluding seasonal migrants (in Niakhar and Mlomp), population counts are larger in HDSS, especially in 2013. HDSS and PHC have different definitions of compounds, with large differences in Mlomp. There is a better agreement in numbers of households. The vagueness of the notion of compound is at stake here, as well as a tendency to keep individuals in their compound of origin as long as they recognize the authority of the same head, even if dwellings are spread geographically (in Mlomp and Bandafassi). This has important implications for the analysis of living arrangements and household structures.



- ► In Bandafassi and Mlomp, recent births were correctly reported in censuses, with a difference of at most 0.6 child in TFR between HDSS and PHC.
- The case of Mlomp in 2002 illustrates that temporary migrants (with lower fertility rates) need to be excluded from HDSS databases to compare fertility rates with census data.
- In Niakhar, discrepancies in PHC and HDSS fertility rates are larger, probably due to omissions of births (in 2002) and the inclusion of some migrants in the HDSS in 2013 which lowers fertility rates. Apparently some migrants could not be identified from data on temporary absences.

Mortality levels and trends



rect estimates from the censuses are represented compared with the underlying mortality rates in gre

- recent household deaths were particularly underestimated).
- mortality rates in Mlomp in 2002, the sinking of the Joola (a ferry connecting Ziguinchor with Dakar which capsized off the coast of the Gambia)

Conclusions

- Triangulation of survey and census data with HDSS can help to evaluate the quality of retrospective reports and also contribute to expand HDSS databases with socio-economic information.
- Collecting comprehensive data on seasonal migrations in both national censuses and HDSS is needed to adequately reflect demographic patterns in local areas and reduce biases caused by selective migration.
- Indicators on family structure, living arrangements and poverty obtained from different data sources can yield very different insights because of differences in residency rules and definitions of compounds.

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Age-specific mortality rates based on consistent with HDSS data except for young children (infant mortality was HDSS and PHC registered high because dozens of residents died in

- Reports on children ever born and surviving were used to derive indirect estimates of child mortality in Bandafassi and Niakhar (the population is too small in Mlomp).
- In Bandafassi, the trend obtained indirectly is quite close to the actual mortality levels, although the level is about 10% too low.
- In Niakhar, indirect estimates are consistent with prospective mortality data until the mid-2000s, but the mortality peak in the late 1990s is not represented (indirect estimates smooth out irregular trends). Recent estimates, based on women under 30 in 2013, indicate an implausible rise in mortality, which could be due to recall errors. More research is needed based on the forthcoming individual-level linkages between HDSS and PHC.

		Bandafassi		Mlo	mp	Niakhar	
		HDSS	PHC	HDSS	PHC	HDSS	PHC
2002	1 9 0	0.11	0.04	0.05	< 0.01	0.06	0.02
	$_{4}q_{1}$	0.09	0.11	0.04	0.05	0.08	80.0
	45 9 15	0.25	0.21	0.54	0.59	0.26	0.24
	20 9 60	0.68	0.71	0.64	0.43	0.52	0.49
	e_0	54.3	58.4	46.6	46.3	59.6	62.8
	e 5	61.9	62.9	45.7	43.5	64	64.5
2013	1 9 0	0.06	0.08			0.02	0.02
	$_{4}q_{1}$	0.04	0.04			0.02	0.03
	45 9 15	0.29	0.38			0.13	0.19
	20 9 60	0.59	0.48			0.52	0.52
	e_0	61.1	58.8			70.7	68.7
	e 5	62.4	61.3			68.7	66.6

estimates cannot be computed for Mlomp in 2013 because of small population size and low mortality

• Adjustments to mortality rates above age 5 should be limited: differences in e_5 between HDSS and PHC were at most 2.2 years. The 2013 census even registered slightly higher mortality rates than the HDSS.