HEALTH AND DEMOGRAPHIC SURVEILLANCE SYSTEM PROFILE

The Kaya HDSS, Burkina Faso: a platform for epidemiological studies and health programme evaluation

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	The Kaya Health and Demographic Surveillance System (Kaya HDSS) is located in the North Central region of Burkina Faso in the Kaya health district. The main purposes of the Kaya HDSS are to study demographic, infectious and chronic disease indicators in the district, to observe changes in health over time, evaluate health programmes and to provide a basis for policy decisions and capacity building in order to enhance the health of the community. Kaya HDSS was established in late 2007 following a baseline census of the population of the HDSS area. Homes were visited every 6 months to collect demographic information and data on morbidity and mortality. A verbal autopsy questionnaire is used to collect information on the causes of death. The Kaya HDSS reached 64 480 residents in 10 587 households by the end of 2011, with an average of 6.1 ± 4.3 persons per household. The site is 70% urban and 30% rural. The population is 51.8% female. Over 55% of deaths occur outside health facilities. Malaria is the leading cause of death, primarily affecting children under 5 years of age (44%) and those 5 to 14 years old (36%). The Kaya HDSS data can be obtained by sending a request via the HDSS website (http://kaya-hdss.org/).

Why was the Kaya HDSS set up?

The Kaya Health and Demographic Surveillance System (Kaya HDSS) was established in late 2007 by the interdisciplinary research team for HIV/AIDS and Reproductive Health (ERIS) of the Institute for Research in Health Sciences (IRSS). It is located in the Kaya health district in the North Central region of Burkina Faso. IRSS is a specialized structure of the National Centre for Scientific and Technological Research (CNRST) whose mission is to conduct research, to provide solutions to the health problems of the country, to coordinate health sector research in Burkina Faso and to disseminate the research results. Given that the lack of relevant health information was a hindrance to the assessment of population-level health as well as to the development of health care interventions and their evaluation, IRSS wanted to contribute by generating quality data on a regular basis through the establishment of a HDSS. The HDSS was established to serve as a platform for evaluating

health interventions in compliance with IRSS's mission and to provide a framework for study projects, ERIS research programmes and its partner's research.

The specific objectives of the Kaya HDSS are as follows: (i) to document the health needs of the population and its determinants; (ii) to evaluate the impact of interventions on population-level health; (iii) to study the changes in infectious diseases (malaria, tuberculosis, HIV/AIDS), chronic diseases [diabetes, hypertension (HTN)] and reproductive health; (iv) to create a platform for clinical research. Another priority of the HDSS was to establish a 'knowledge broker' whose role is to transform the results of scientific research into an appropriate format and to disseminate them, as well as to strengthen links between researchers and target users (stakeholders and decision makers at local and national levels).

What does it cover now?

Kaya HDSS serves as a research platform for equity in maternal and child health interventions in urban and rural contexts. It aims to identify the characteristics of and trends in morbidity and mortality, specifically the causes of death for children under 5 years of age (funded by National Malaria programme).

We have implemented the reproductive health project 'Missed Opportunities for Maternal and Infant Health' (MOMI) funded by the European Union (FP7) since 2011.

The Kaya HDSS platform has been used since 2011 to evaluate the scaling up of interventions against malaria in Burkina Faso (BF-MEILUP). Instituts de recherche en Santé du Canada (IRSC) has also funded a project on equity and health in the Kaya HDSS since 2012. The programme's goal is to document the process and effectiveness of promising community interventions to improve health equity in Burkina Faso, a limited resources country. On the basis of a stakeholder participatory planning process, the first objective of the programme is to evaluate community-based interventions that are under way in the district of Kaya (free health care for children under 5 years, community based management of malaria, the distribution of bed nets) to provide evidence of their effectiveness on health equity. The second objective is to formulate, implement and evaluate the best practices of interventions based on equity.

Where is the HDSS located?

The Kaya HDSS is located in the North Central region of Burkina Faso in the health district of Kaya, 100 km from the capital, Ouagadougou (Figure 1). Access to the site is very easy from National Highway No 3. The survey covers the town of Kaya and 18 villages in the Kaya health district.

There are seven primary health facilities in the HDSS area, (four urban and three rural) and one regional hospital.

Vegetation is limited to sparse, thorny bushes. The climate is tropical, marked by two seasons: a long, dry season from October to May and a short, rainy season from June to September. The dry season is characterized by a harsh dry wind (harmattan), a factor which favours epidemic-prone diseases. Rainfall is scarce and average 5-year precipitation is estimated to be between 600 and 700 mm and is often poorly distributed in time and space. This results in dietary limitations that affect the health of the population.

The leading causes of death and hospital visits of the region in which the Kaya HDSS is located are malaria (the most vulnerable groups are children aged 0–5 years and pregnant women: in 2009 there was a prevalence of 50.3% of severe malaria in children under 5 years with morbidity of 2.6%), respiratory diseases and low use of family planning services.[1] The socio-economic context is characterized by the predominance of subsistence agriculture and livestock trade. Artisanal and industrial gold mining is highly developed in the administrative region but no such site is operating in the HDSS area.

Who is covered by the HDSS, and how often have they been followed up?

At the end of 2011, the population under surveillance in the Kaya HDSS comprised 64 480 inhabitants living in 10 587 households, with an average of 6.5 ± 4.3 persons per household. The site is 70% urban and 30% rural. The population is 51.8% women, the same as for the country in general. In fact, 55.5% of the population is under 20 years of age (54.1% in urban vs 58.5% in rural areas) (Figures 2 and 3). Children under 14 years of age represent 40.7% of the population. The population is even younger in rural areas (Figure 3).

Islam is the main religion of the site (78.9%). Other faiths include Catholic (17.1%), Protestant (3.3%) and animist (0.6%).

Agriculture and livestock breeding are the two main occupations. Agriculture remains rudimentary and is practised on small plots.

The majority of the population of the HDSS (53.3%) have not been to school. Women (60.4%) are proportionately more likely not to have attended school than men (45.5%).
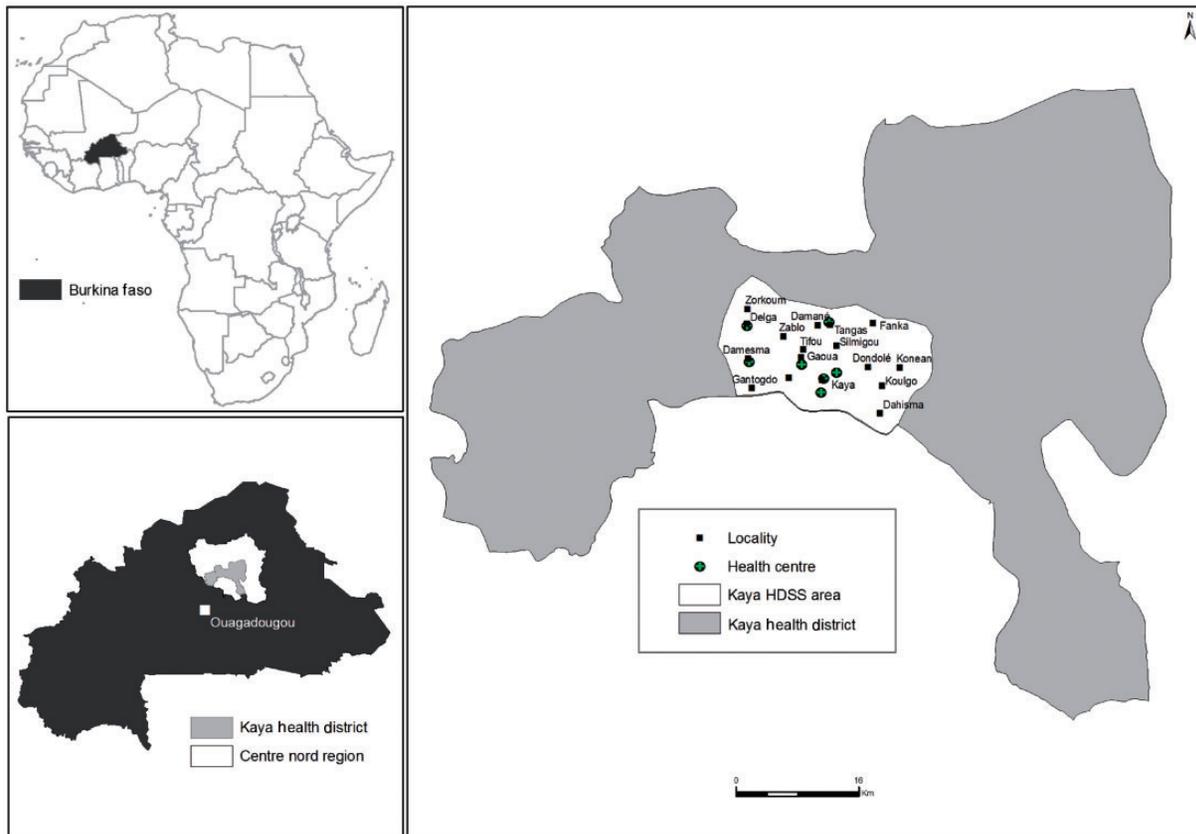
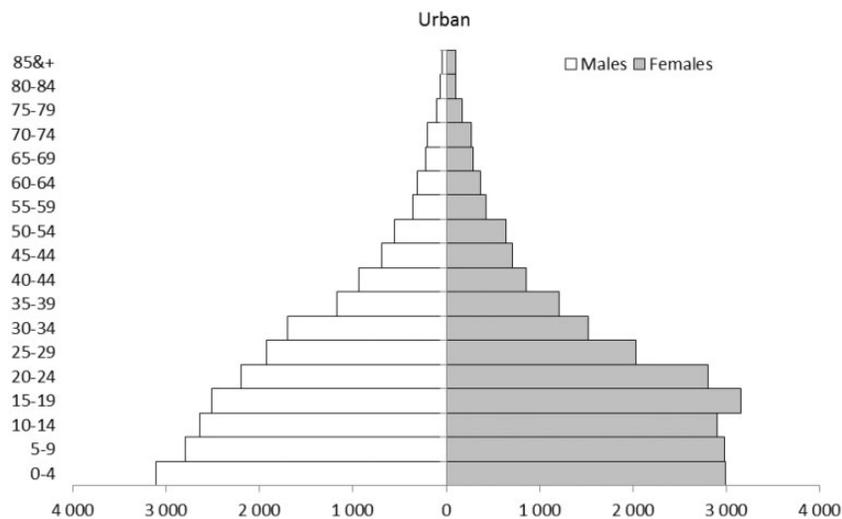**Figure 1** The Kaya HDSS site, Burkina Faso

Figure 2 Urban male and female population by age, 2011, Kaya HDSS

What has been measured and how have the HDSS databases been constructed?

Based on the information collected in the baseline census (at the end of 2007), a longitudinal follow-up of the population has been initiated. It involves repeated surveys to monitor events such as pregnancy, birth, death, maternal and infant morbidity, child and maternal mortality, marriages, migration and household assets (Table 1).

Details regarding the date of birth, sex of the child, live birth or stillbirth, weight and place of birth are recorded on a specific form. In addition, death forms
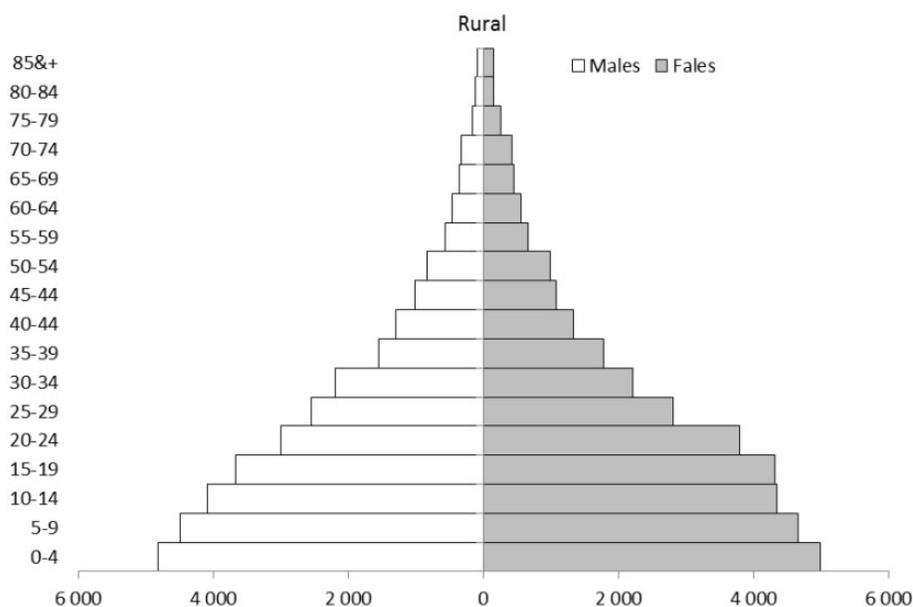
Figure 3 Rural male and female population by age, 2011, Kaya HDSS

are completed for each death. New marriages are registered with a specific form, providing information on the kind of marriage, the wedding date, place of origin of the spouse, age, and education level and rank of the wife. The migration form documents the place of origin and the destination as well as the reasons for the change of locality. Verbal autopsies (VA) are performed for all HDSS registered deaths using the World Health Organization standardized verbal autopsy questionnaire to interview family members who were present at the time of death.

The interpretation of data to determine the probable cause of death is performed by the physicians of the regional hospital and some from the district hospital. ICD-10 codes are used to code the causes of death. The VA coding follows the procedure shown in Figure 4.

Follow-up methods used by the Kaya HDSS

The baseline census
The initial census of the population of selected villages was conducted from July to September, 2007, to establish a reference population and a monitoring system that enabled us to periodically record vital events occurring in households. During this census, 48 131 people were recorded as living in 7682 households.

The update rounds
Updates are performed every 6 months. During an update, fieldworkers visit each household with a Personal Digital Assistant (PDA) containing information on the household collected during the preceding round. Any event (birth, death, marriage, migration, pregnancy, morbidity) that occurred since the previous round is recorded. The fieldworkers administer a pregnancy questionnaire to all pregnant women in the household. A specific questionnaire is also administered to women who delivered during the period between the previous and current rounds.

Management and data analysis
The software ERIS-HRS has been used to manage the databases. Derived from the Household Registration System 2 (HRS2) software, it uses a MySQL database and a web interface in Hypertext Preprocessor (PHP). Since 2008, data are directly entered on Pocket PCs using the software CSproX and CSPro versions 4, respectively, and then transferred to ERIS-HRS.

Key findings and publications
Population-wide fertility levels in the HDSS are quite high, with a total fertility rate (TFR) of 6.9 children per woman. The average age at childbearing is 27.6 years [95% confidence interval (CI) 27.4 to 27.8 years]. Figure 5 shows the evolution of the age-specific fertility rate.

Despite providing deliveries free of charge at the Kaya HDSS from 2007 to 2011, 14% of women deliver at home. Almost all home births take place in rural areas and the distance of health facilities from home is a major reason for home deliveries. Home births increase with distance from health facilities (Figure 6). The percentages of women who give birth at home are 1.2%, 28.7% and 58.6% of those living less than 2 km,

Table 1 Events followed in Kaya HDSS

| Level/Event	Frequency of monitoring	Collected information
Village		Global Positioning System (GPS) of public place (market, school, health facility)
		GPS of points of water (fountain, lake)
		GPS Tracking of the most used roads connecting the village to the nearest health centre
Household	Every 2 years	Household assets (materials, possessions, type of combustible used, dwelling owned, source of drinking water, kind of toilet facilities, type of fuel used for cooking, main material of the floor, having a bicycle, a motorcycle or a car, having electricity, a radio, a television, phone or a refrigerator).
		Characteristics of the head of the household (sex, age)
		Types of crops produced
Individual		
Births	Every 6 months	Date of birth
		Place of delivery
		Child's weight at birth
		Type of vaccinations received
		Child survival
		Expenses related to childbirth
		Morbidity related to childbirth and pregnancy
Deaths	Every 6 months	Date of death
		Place of death
		Causes of death
		Coordinates of the family member or parent or a friend who attended the deceased person
Migrations	Every 6 months	Date of immigration or emigration
		Type of migration
		Place of migration
		Reasons for migration
Pregnancies	Every 6 months	Length of pregnancy
		Possession of a health card
		Number and dates of antenatal care conducted
		Reasons for non-receipt of prenatal care
		Location for monitoring of pregnancy
Marriages	Every 6 months	Date of the union
		Type of union (monogamy/polygamy)
		Provenance of the spouse
Morbidity	Every 6 months	Type of morbidity during the previous 2 weeks
		Reliance on care
		Type of care
		Expenses borne
Verbal Autopsies	Every 6 months	WHO Verbal Autopsy questionnaires used to gather information
Malaria	Once per year	Use of nets
		Rapid diagnostic test of malaria for children under 5 years
		Test of anaemia for children under 5 years
		Weight of children
		Height of children
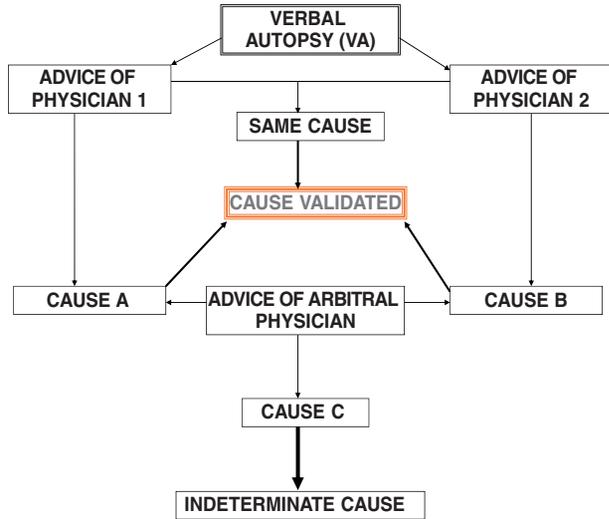
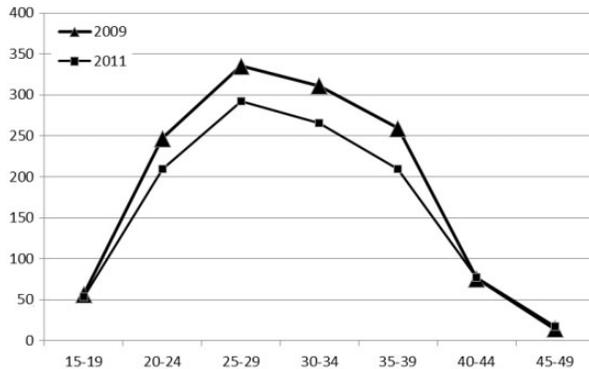**Figure 4** Verbal autopsy coding procedure in Kaya HDSS
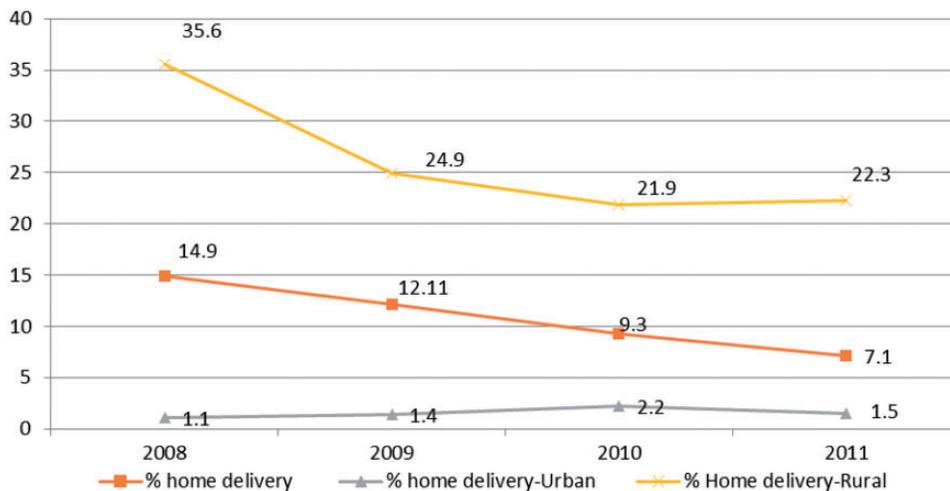

Figure 5 Age-specific fertility rate (2009, 2011)

2 to 5 km and more than 5 km from health facilities, respectively ($P < 0.001$).[2,3]

The crude mortality rate (CMR) is estimated to be 9.5%. Life expectancy at birth is 53.8 years (Table 2).

Among the population under surveillance, the main causes of death are malaria (20%), diarrhoea (12.4%), renal failure (7.5%), cardiovascular diseases (6.5%) and cancer (5.9%). HIV/AIDS, sexually transmitted infections (STIs) and other diseases are also a significant health burden in the population. After malaria (48.8%), the leading causes of death among children under 5 years of age are acute diarrhoea (12.8%), neonatal causes (8%), ARI (acute respiratory infections) (4.8%) and malnutrition (4.8%). Measles, HIV/AIDS and meningitis are uncommon but not negligible (Table 3). Analysis did not reveal significant differences in causes of mortality between boys and girls or between urban and rural areas.[4,5]

In 2009, a study on the use of the partogram during labour and delivery was conducted. According to the WHO, the partogram is a simple monitoring tool for the first stage of labour. The tool allows a skilled birth attendant to monitor the progress of labour, the mother and the foetus on an hourly basis and provides a clear means of tracking whether labour is obstructed with 'alert' and 'action' lines signalling when a labour has become complicated.

Of 600 deliveries, 20.2% involved the use of a partogram. This rate varied across health facilities ($P < 0.001$). It also depended on the background of the women, including the number of pregnancies, history of stillbirths or abortions, appearance of amniotic fluid [odds ratio (OR) 1.83, 95% CI 1.1 to 3], blood pressure (OR 2, 95% CI 1.2 to 3.5 1), existence of lower limb oedema or presence of complications ($P < 0.001$). The proportion of partographs that were of good quality (quality score $\geqslant 7/10$) was 57.9%.[6,7]

Figure 6 Evolution of the rate of home delivery in Kaya HDSS (%)

The Kaya HDSS platform was used in 2011 to evaluate the scaling up of interventions against malaria in Burkina Faso (BF-MEILUP). The BF-MEILUP programme was implemented by the government of Burkina Faso in order to fight malaria. This programme has two components: (i) a large distribution of mosquito nets with a long duration of action (MILDA) to the community and (ii) the care of patients with malaria by the community health workers (PECADO). Ninety per cent of households reported having received bed nets. The prevalence of malaria among children under 5 years of age was 27.3% and two-thirds of these were anaemic with a statistically significant association between the prevalence of malaria and anaemia.[8–10]

Strengths and weaknesses

Our Health and Demographic Surveillance System produces data for the evaluation of health policies and provides a platform for clinical and epidemiological research. Our site has a multidisciplinary team, including physicians, epidemiologists, public health and programme evaluation experts, demographers, anthropologists, health economists, nutritionists and statisticians. There is a biomedical laboratory. We also have strong links to the health system, which allows research results to be used to establish new policies. To ensure a link between researchers and policy-makers, we have employed a knowledge transfer specialist called a 'knowledge broker' who oversees the dissemination of information to decision makers. Kaya HDSS has also served as a research platform for PhD students from Burkina Faso, Belgium and

Table 2 Demographic characteristics of Kaya HDSS population

Crude birth rate (CBR)	51.9 per 1000 population
Total fertility rate (TFR)	6.9 per woman
Crude death rate (CDR)	9.5 per 1000 population
Life expectancy at birth	53.8 years
Neonatal mortality	25.3 per 1000 live births
Post-natal mortality	46.7 per 1000 live births
Infant mortality	71 per 1000 live births
Child mortality (1–4 years)	17.1 per 1000 children aged 1–4 years
Rate of natural increase	20.26 per 1000 population

Table 3 Causes of death in Kaya HDSS population (1 January 2008 to 31 December 2010)

|	All			Under 5 years			Ages 5 and over		
Cause of death (%)	Urban $N=348$	Rural $N=248$	Total $N=596$	Urban $N=68$	Rural $N=70$	Total $N=138$	Urban $N=280$	Rural $N=178$	Total $N=458$
Malaria	14.4	17.7	15.8	38.24	50.0	44.2	8.6	5.1	7.2
Infectious and parasitic diseases (without malaria)	5.7	2.0	4.2	1.47	0.0	0.7	6.8	2.8	5.2
Tumors	8.0	4.0	6.4	0.0	1.4	0.7	10.0	5.1	8.1
Endocrine and nutritional disorders	5.2	4.8	5.0	13.24	10.0	11.6	3.2	2.8	3.1
Diseases of the circulatory system	10.6	4.4	8.1	1.47	1.4	1.5	13.2	5.1	10.0
Respiratory diseases	0.9	0.8	0.8	1.47	1.4	1.5	1.8	1.1	1.1
Digestive diseases	4.9	3.2	4.2	0.0	0.0	0.0	5.7	3.9	5.0
Renal and urological diseases	1.7	3.2	2.3	0.0	0.0	0.0	2.1	4.5	3.1
Mental illness and nervous system	1.4	0.4	1.0	0.0	0.0	0.0	1.8	0.6	1.3
Disorders related to pregnancy	0.9	0.0	0.5	0.0	0.0	0.0	1.1	0.0	0.7
Perinatal causes of death	2.3	22.2	10.6	10.29	14.3	12.3	0.4	25.3	10.0
External causes	6.0	4.0	5.2	1.47	0.0	0.7	7.1	5.6	6.6
Undetermined	8.0	7.7	7.9	2.94	1.4	2.2	9.3	10.1	9.6
Bronchopneumonia/pneumonitis	5.7	7.3	6.4	2.94	4.3	3.6	6.4	8.4	7.2
Diarrhoea	6.6	2.8	5.0	4.41	2.9	3.6	7.1	2.8	5.5
Infectious diseases undetermined	10.3	6.0	8.6	10.29	4.3	7.3	10.4	6.7	8.9
Meningitis	4.3	4.4	4.4	13.24	5.7	9.4	10.37	3.9	2.8
Septicaemia	2.9	4.8	3.7	0.00	1.4	0.7	10.38	6.2	4.6
Total	100.0	100.0	100.0	100.00	100.00	100.00	100.0	100.0	100.0
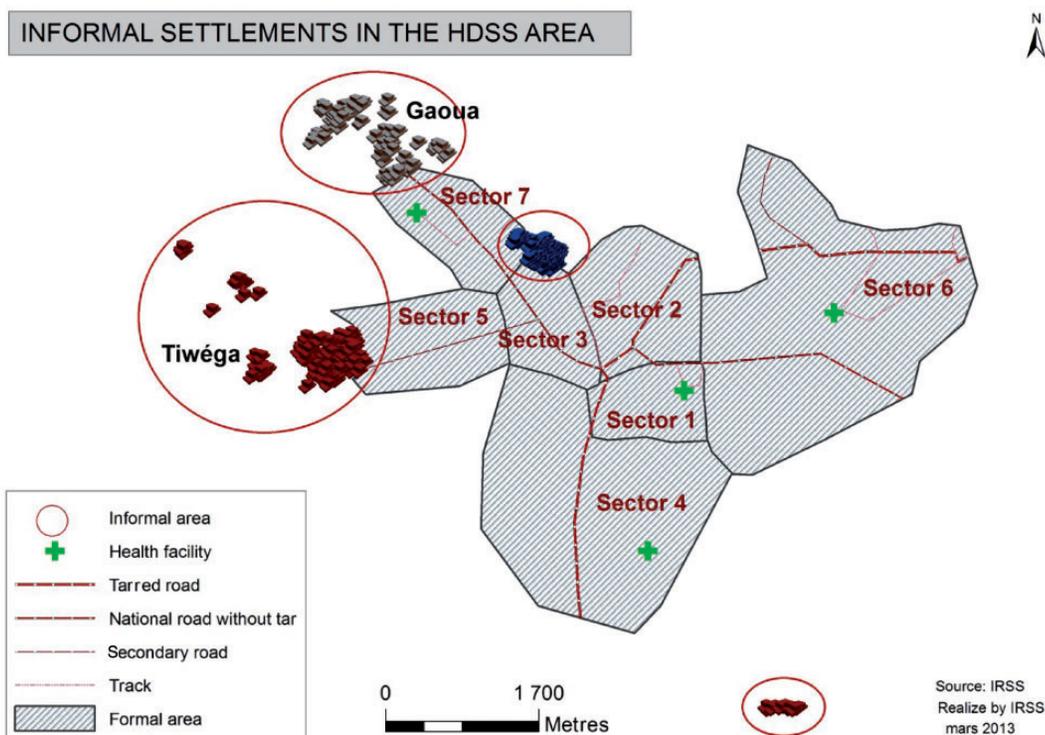
Figure 7 Informal settlements in the HDSS area after baseline census

Montreal. However, some challenges still remain. The first challenge is that people do not always understand the objectives and purpose of the Health and Demographic Surveillance System, and some unexpected behaviour occurs.[11] For the baseline census, communication strategies and a sensitization campaign were conducted in order to gain population support and improve enrolment in the demographic surveillance system. However, these strategies did not yield the expected results: more than 6000 fictitious persons were reported by respondents as member of the household and a significant number of members' names were false. In addition, some thought that the baseline census was to mean to distribute plots of land to people so that, after the baseline census, new informal settlements were built in the outskirts of the town of Kaya (Figure 7). Following this misunderstanding, various measures were taken: (i) awareness campaigns were initiated to inform the public about the activities of the HDSS, (ii) feedback sessions were organized in the villages to share the results of the campaign and (iii) community leaders were involved in the development of research projects on the HDSS site and the steering committee of the research projects.

Another challenge is to ensure the long-term funding of the site. The last challenge is the production of quality data and publications to provide greater visibility for the site. Cultural barriers still make people reluctant to provide information concerning their daily life, including reporting the deaths of young children.

Future analysis plans

The aim of the Kaya HDSS is to use the data collected to produce scientific papers and policy documents. A research agenda has been developed based on the profiles of the researcher team. The research themes are as follows: evaluation of nutritional interventions on the health status of children, poverty and community health insurance; evaluating the policy of EMergency and Neonatal Obstetric Care (EmnOC); assessing the impact of support for home management of malaria; assessing the impact of the distribution of insecticide-treated nets; and evaluating mortality trends, population dynamics and migration, and the emergence of chronic diseases (hypertension, diabetes).

Data sharing and collaboration

The development of partnerships and the collaboration of researchers is one of the priorities of the Kaya HDSS. Although the data sharing policy is not yet clearly defined, Kaya HDSS data are available to both national and international researchers. Data can be obtained by sending a letter to officials via the HDSS website (http://kaya-hdss.org/). Kaya HDSS is

collaborating with other HDSSs in Burkina Faso (Ouagadougou, Sapone and Nouna) with the aim of combining data and undertaking a comparative analysis of demographic data dynamics (mortality, migration, fertility).

KEY MESSAGES

- The Kaya HDSS is a platform for the evaluation of health interventions and clinical trials.
- The site spans both urban and rural areas, providing a unique opportunity to study infectious and chronic diseases.
- Child mortality remains high due to infectious diseases such as malaria.
- Translation of policy-relevant findings for decision makers is undertaken by a 'knowledge broker'.

References

[1] Health District of Kaya. *Action Plan of the Health District of Kaya*. 2010, Health District of Kaya. Kaya, Burkina Faso.

[2] Kouanda S, Nongana G. Using GIS to determine the factors associated with home deliveries in the demographic surveillance site of Kaya. INDEPTH Scientific Conference, 2–27 October 2011, Maputo, Mozambique, Abstract YS9 2011;114–15.

[3] Tiendrebeogo S, Bado A, Belemsaga D, Nongana G, Kouanda S. Prévalence et facteurs associés aux accouchements dans le district sanitaire de Kaya [Prevalence and factors associated with home deliveries in the Kaya health district]. Présentation Affichée Journées de Sciences de la Santé de Bobo, 8–11 May 2012, Bobo Dioulasso, Burkina Faso, Poster P132 164, 2012;164.

[4] Kouanda S, Maurice Y, Boukary D, Juste N, Blaise S. Analysis of mortality in the demographic surveillance site of Kaya (KaDeSS) Second Scientific Communication Days of Nouna, 3–5 December 2009. Nouna, Burkina Faso.

[5] Hien T. Determinants of causes of death of children under 5 of Kaya Demographic and Epidemiologic Surveillance System. PhD Thesis. Faculty of Medicine, University of Ouagadougou, Burkino Faso, 2011.

[6] Ouedraogo H. Assessment of the utilization of partogram in the supervision of the labor of childbirth in Kaya district, Burkina Faso. Faculty of Medicine, University of Ouagadougou, Burkino Faso, 2010.

[7] Nikiema/Ouedraogo L, Kouanda S, Seck I, Ouedraogo H, Sondo B. Evaluation de l'utilisation du partogramme pour la surveillance du travail d'accouchement dans le district sanitaire de Kaya [Assessment of the utilization of the partogram in the monitoring of labor of childbirth in Kaya health district, Burkina Faso]. *Science et Technique* 2011; *Sciences* **34**:103–10.

[8] Millogo T, Druetz T, Bado A et al. Prévalence du paludisme chez les enfants de moins de 5 ans dans les districts sanitaires de Kaya et Zorgho [Prevalence and risk factors of malaria in children under five years in the health districts of Kaya and Zorgho, Burkina Faso]. Journées de Sciences de la Santé de Bobo, 8–11 May 2012, Bobo Dioulasso, Burkino Faso, 2012.

[9] Millogo T, Druetz T, Bado A et al. Niveaux de possession dans les ménages et pratiques d'utilisation des moustiquaires mprégnées d'insecticides chez les enfants de moins de 5 ans dans les districts sanitaires de Kaya et Zorgho, huit mois après la campagne MILDA [Ownership and utilization of treated bed-nets in children under five years in the health districts of Kaya and Zorhgo, 8 months after the bed-nets mass-distribution campaign]. Présentation Affichée Journées de Sciences de la Santé de Bobo, 8–11 May 2012, Bobo Dioulasso, Burkina Faso, Abstract P123, 2012;160.

[10] Kouanda S, Komboigo E, Bado A, Tiendrebeogo S. La campagne de distribution des MILDA a-t-elle atteint tous les ménages?: Résultats d'une étude comparative 2010 et 2011 à Kaya [Did the mass-distribution of bed-nets reach the households?: Findings from a comparative before-after study in Kaya Health and Demographic Surveillance System]. Présentation Affichée Journées de Sciences de la Santé de Bobo, 8–11 May 2012, Bobo Dioulasso, Burkina Faso, Poster P101 2012;160.

[11] Bado A, Nitièma J, Yaméogo M, Kouanda S. Challenges of the implementation of a HDSS in a city in full expansion: the case of Kaya HDSS. INDEPTH Scientific Conference, 24–27 October 2011, Maputo, Mozambique, Abstract Pa 821 2011;85–86.