The influence of climatic variations on child survival in Burkina Faso

Sabine Henry[*] & Stéphanie Dos Santos Beauchamp[♦]

Context and objective of the study

In sub-Saharan Africa, health conditions continue to be the worst of all developing regions and child mortality rates are running at an average rate of 174 deaths per 1000 babies born, compared with 121 per 1000 in low income regions as a whole (World Bank, 2004). Beyond the effects of the classical determinants of child survival (mothers' and fathers' education, birth interval, economic status of the household, etc.), ecological factors (such as drought or land degradation) can have a strong influence on child survival in rural subsistence societies, particularly through their impact on malnutrition and on income reduction. More precisely, ecological factors affect the quantity and variety of food crops produced and the quantity and quality of water. They can also influence the availability of income-generating work, the access to and use of medical facilities, and the time mothers can spend at home in child care. However, even if the importance of the ecological factors have already been emphasized in the well-known article written by Mosley and Chen (1984) on the determinants of child survival, there is little empirical evidence on this topic.

In the early 1970s, in sub-Saharan Africa 70 million people were affected by chronic food shortages, and this number attained 100 million by 1985 (Kiros and Hogan, 2000). Famine induced by drought has almost certainly contributed to continued high African mortality levels (Caldwell and Caldwell, 1992). Persistence of unfavourable climatic conditions could lead to not only a sharp reduction of the food production but also to the disorganisation of food distribution. The consequence for population is a deterioration of alimentation (Palloni, 1988), and the availability of a basic minimum food supply of sufficient variety is critical to ensure adequate amounts of all nutrients. The most vulnerable groups to excess famine deaths are the young and the old (Kiros and Hogan, 2000). In Niakhar (Senegal), 60% of deaths among children aged 1 to 60 months have been attributed to malnutrition (Garenne *et al.*, 2000). The infant survival is expected to decrease because the malnutrition, by reducing birth weight, influences the neo-natal and post-neonatal mortality (Palloni, 1988). Maternal diet and nutrition during pregnancy also affect birth weight and, during lactation, influence the quantity and nutrient quality of breast milk (Mosley and Chen, 1984). In case of breastfeeding, babies are less vulnerable of strong food reduction than expected, except if breastfeeding is not exclusive or if malnutrition also concerns the mothers. Besides, the survival of children aged 1 to 5 is very sensitive to the food shortage because of the needs of solid food of young children and because their immune system is not completely developed (Palloni, 1988). Moreover, famines help the rapid spread of disease through the weakening of

[*] Département de démographie. Université de Montréal. CP 6128, succ. Centre-Ville. Montréal (QC). H3C 3J7. CANADA. tel : 001.514.343.6111 ext. 1959. fax : 001.514.343.2309. sabine.henry@umontreal.ca

[♦] Département de démographie. Université de Montréal. CP 6128, succ. Centre-Ville. Montréal (QC). H3C 3J7. CANADA. tel : 001.514.343.6111 ext. 1963. fax : 001.514.343.2309. s.dos.santos@umontreal.ca

immune systems, through resulting migrations, through the breakdown of sanitary services, and through the readiness of famine victims to eat whatever they can get (Kiros and Hogan, 2000).

In addition on malnutrition, ecological factors may have influence on child survival by the reduction of income. In period of drought, rural families experience many difficulties such as the reduction of food production, abnormal increases in food grain prices and the non-availability of jobs (Paul, 1998). In poor societies in particular, families may spend 80 percent or more of their disposable income on food; thus variations in income or food prices may directly translate into rising rates of malnutrition mortality. In rural subsistence economies, even seasonal variability in income and/or food availability may lead to seasonal swings in mortality. In addition, rainfall seasonality may also have effects on pathogens by increasing the development of water-related vectors, the development of water-borne diseases (such as diarrhoea), or the development of water-washed diseases.

In this study, we examine ***the influence of climatic variations on child survival in Burkina Faso***. This country experiences high levels of child mortality compared to his west-African neighbourhoods (WHO, 2004), with large geographic disparities within the country. The child mortality rate is 116 per thousand in the West region while it is more than 180 per thousand in the Sahel, the East and the Centre regions (Schoumaker, 2002). In terms of rainfall, this Sahelian country is characterized by a strong south-north decreasing gradient of average annual rainfall. In the northern part of Burkina Faso, rainfall is scarce and irregular, with an average annual precipitation below 500 mm. The agro-climatic conditions are thus very constraining for agriculture and the main economic activities are extensive pastoralism and rain-fed agriculture of pearl millet and sorghum (Hampshire and Randall, 1999). The conditions are more suitable for agriculture in the southern part of the country (average rainfall above 900 mm), where the main crops include maize and cotton in addition to millet and sorghum (Ingram *et al.*, 2002). The country's rainfall is also characterized by a high degree of annual variability (Roncoli *et al.*, 2001). Large year-to-year variations in total precipitation translate into extremely variable crop outcome and uncertainty at the household level (Reardon *et al.*, 1988; Roncoli *et al.*, 2001).

Data

An original aspect of this work is the use of exceptionally reliable multi-source data for the study of how climatic variations influence child survival in Burkina Faso.

1. Individual and household data are provided by a nationally-representative detailed retrospective (life-history type) survey, conducted in 2000 by the UERD of the University of Ouagadougou, the Demography Department of the University of Montreal and the CERPOD (Poirier *et al.*, 2001). In all, 9,612 life histories were collected from 3,570 households in the sample. The household questionnaire included questions on the individual characteristics of the different members and on their housing conditions. The detailed biographic questionnaire covered family origins, migration, employment, matrimonial and fertility histories. In this last unit, 3,751 women were surveyed, with 17,544 births and 3,268 deaths among these children.

2. Rainfall data covering the 1960-1998 period have already been obtained from the global monthly precipitation data set produced by the Climatic Research Unit at the University of East Anglia (New *et al.*, 2000). These data have been interpolated from a network of stations at a spatial resolution of 0.5 degree latitude and longitude, and have been linked to the survey data above. In the literature, season at birth is often used as proxy for climatic influence (Blacker, 1991). In this study, **the mean annual precipitation over the 1960-1998 period and the percent of normal precipitation over the three preceding years** are used. The first variable is considered to be a good indicator of agricultural productivity and of vulnerability to drought. The second variable is a time-varying variable indicating the extent to which rainfall in the department over the three preceding years differed from the long-term rainfall conditions in the department. It is measured as the ratio of the mean rainfall over the three preceding years to the mean rainfall over the 1960-1998 period.

Methods and expected results

Multilevel event-history methods are used to estimate the impact of various characteristics of the environment on child survival, controlling for relevant variables related to the child (sex, rank, generation) and his or her mother (education, age at the child's birth, migratory status, standard of living). The event history approach allows us to take into account time-varying explanatory variables. Multilevel models are used to model and correct for the correlation of observations at multiple levels. In terms of expected results, child survival is expected to be higher in semi-urban areas in case of adverse climatic events than in the villages, because semi-urban households have probably more means to cope in period of drought. As found in Balk et al. (2003), the unweaned infants are expected to be less vulnerable to climatic variations than children aged 1-5, thanks to the protection by breastfeeding (Palloni, 1988).

Although many researchers are convinced of the benefits of multi-disciplinary studies, practical issues have often limited their number. In terms of ecological factors, population scientists content themselves with available data (often coarse classifications of rainfall or environmental vulnerability). In this study, rainfall variables are measured with accuracy at fine spatial and temporal resolutions. In addition, the event-history approach allows us to take into account the conditions of the child environment during his or her first five years and not only at the time of the survey, as has generally been done by previous studies. The likelihood of child survival could be different if for example a child moved during his first five years from a village with unfavourable climatic conditions to a village with favourable climatic conditions. Our approach takes this residential change into account, by using the mother's migratory history collected by the survey.

References

BLACKER, J. G. C. 1991. "Infant and Child Mortality : Development, Environment, and Custom", dans FEACHEM, R. G. and JAMISON, D. T., éd. *Infant and Child Mortality : Development, Environment, and Custom*. World Bank Publication, Oxford University Press: 75-86.

CALDWELL, J.-C. and CALDWELL, P. 1992. "Famine in Africa:a global perspective", dans WALL, V. D., PISON and SALA-DIAKANDA, éd. *Famine in Africa:a global perspective*. Clarendon Press: 367-390.

GARENNE, M., MAIRE, B., FONTAINE, O., DIENG, K. and BRIEND, A. 2000. *Risques de décès associés à différents états nutritionnels chez l'enfant d'âge préscolaire.* Paris, CEPED, 201 p.

HAMPSHIRE, K. and RANDALL, S. 1999. "Seasonal Labour Migration Strategies in the Sahel: Coping with Poverty or Optimising Security?" *International Journal of Population Geography*, 5, 5: 367-385.

INGRAM, K., RONCOLI, M. and KIRSHEN, P. 2002. "Opportunities and Constraints for Farmers of West Africa to Use Seasonal Precipitation Forecasts With Burkina Faso as a Case Study", *Agricultural Systems*, 74, 331-349.

KIROS, G.-E. and HOGAN, D. J. 2000. "The impact of famine, war, and environ,ental degradation on infant and early child mortality in Africa: the case of Tigrai, Ethiopia", *Genus*, LVI, 3-4: 145-178.

MOSLEY, W. H. and CHEN, L. C. 1984. "An Analytical Framework for the Study of Child Survival in Developing Countries", *Population and Development Review*, supplement to 10, 25-45.

NEW, M., HULME, M. and JONES, P. 2000. "Representing 20th Century Space-Time Climate Variability. II: Development of 1901-1996 Monthly Trimestrial Cimate Fields", *Journal of Climate*, 13: 2217-38.

PALLONI, A. 1988. "Les mortalités de crise: leur estimation, leurs conséquences", dans VALLIN, J., D'SOUZA, S. and PALLONI, A., éd. *Les mortalités de crise: leur estimation, leurs conséquences*. INED, UIESP, PUF: 215-249.

PAUL, B. K. 1998. "Coping mechanisms practised by drought victims (1994/5) in North Bengal, Bangladesh", *Applied Geography*, 18, 4: 355-373.

POIRIER, J., DABIRÉ, B., LE JEUNE, G., PICHÉ, V. and WANE, H. R. 2001. "Projet d'étude des stratégies de reproduction des populations sahéliennes à partir de l'enquête *Dynamique migratoire, insertion urbaine et environnement au Burkina Faso*", *Cahiers québécois de démographie*, 30, 2: 289-309.

REARDON, T., MATLON, P. and DELGADO, C. 1988. "Coping With Household Level Food Security in Drought Effected Areas of Burkina Faso", *World Development*, 16, 9: 1065-1074.

RONCOLI, C., INGRAM, K. and KIRSHEN, P. 2001. "The costs and risks of coping with drought: livelihood impacts and farmers'responses in Burkina Faso", *Climate Research*, 19, 119-132.

SCHOUMAKER, B. 2002. *Enquête sur la migration, l'insertion urbaine et l'environnement au Burkina Faso. Indicateurs de fécondité, nuptialité, contraception, et mortalité*. Unpublished, p.

WHO. 2004. *Core health indicators*. http://www3.who.int/whosis/core

WORLD BANK. 2004. *Millenium Development Goals : eradicating poverty and improving lives.* http://www.worldbank.org/data/wdi2004/pdfs/Table1_2.pdf