XXVI IUSSP International Population Conference

Marrakeh, Morocco 2009

1203 - Interrelations between population and climate change
Organiser: Brian O'NEILL

Why Rainfall Variations influence Child Survival differently in Burkina Faso and Mali ?
Results from a Comparative Event-history Analysis

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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 (Caldwell and Caldwell 1992; Mosley and Chen 1984), particularly through malnutrition (Kiros and Hogan 2000; Palloni 1988), through energy expenditure (Jaffar et al. 2000), through income reduction (Paul 1998) and through the development of water-related diseases (Dyson 1991).

However, even if the importance of rainfall factors on child survival has already been emphasized, there is little empirical evidence on this topic. The few studies dealing with this issue used coarse classifications of rainfall or an indicator determining the season (i.e. Balk et al. 2004).

Objective

This communication presents a comparative event-history analysis to understand how rainfall variations may influence child survival in two Sahelian countries. In Burkina Faso, a first case study has already highlighted how child survival depends on rainfall conditions. More precisely, there are specific patterns of rainfall variations and children's mortality relationships in each burkinabè agro-climatic region (Dos Santos and Henry 2008). The second step of this study has compared results obtained in Burkina Faso with those obtained in Mali. It has shown how child survival is related to specific patterns in each country (Henry and Dos Santos 2008). This communication is the next step and aims to explain why rainfall variations influence child survival differently in these two neighbouring countries.

Context

These countries present similar contexts in terms of population dynamic, economy, livelihood, child mortality as well as rainfall conditions (i.e. strong south-north decreasing gradient of rainfall).

Burkina Faso and Mali experience high levels of child mortality compared to their west-African neighbourhoods (WHO 2004), with large geographic disparities within each countries. In Burkina Faso, the childhood mortality rate is 150 per thousand in the Central region while it is more than 250 per thousand in the Sahel and the North regions (INSD and ORC Macro, 2004). Marked regional differentials in under-five mortality are also observed in Mali. For example, under-five mortality ranges from a low of 219 per thousand live births in Koulikoro Region[3] to a

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[3] Except for the urban region of the Greater Bamako (134 per thousand live births).

high of 291 per thousand live births in the Mopti Region (CPS/MS, DNSI and ORC Macro, 2002).

In terms of environmental context, there is a long history of droughts and related famine in the Sahel. These two Sahelian countries are characterized by a strong south-north decreasing gradient of average annual rainfall. In both countries, three distinctive farming systems are largely determined by rainfall patterns: (1) Pastoral Systems with a high incidence of severe poverty and low potential for poverty reduction; (2) Agro-Pastoral Millet-Sorghum System with a high incidence of severe poverty but with a high potential for poverty reduction and (3) Cereal-Root Crop Mixed System with a lower incidence of poverty but also with a high potential for agricultural growth. Most agricultural production is concentrated in the short rainy season, and climate events affecting the distribution or quantity of rain during the rainy season have historically had a significant impact on food production.

Data

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

1. Individual and household data are provided by two nationally-representative detailed retrospective surveys (life-history type). The first one, *Enquête sur les Dynamiques Familiales et l'Education des Enfants au Mali (EDFEEM)*, was conducted in 2000 in Mali by the Sociology Department of the University of Laval and the CERPOD (Marcoux, et al, 2002). In all, 3 152 women were surveyed, with 16571 births and 2 304 death among them.

The second one, *Enquête Migration, Insertion Urbaine et Environnement au Burkina Faso (EMIUB)*, was conducted in 2000 in Burkina Faso by the ISSP of the University of Ouagadougou, the Demography Department of the University of Montreal and the CERPOD (Poirier et al. 2001). In all, 3 751 women were surveyed, with 17 544 births and 3 268 deaths among them.

These two surveys have followed the same methodology and are thus highly comparable. Household questionnaires included questions on the individual characteristics of the different members and on their housing conditions. Detailed biographic questionnaires covered family origins, migration, employment, matrimonial and fertility histories.

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, Hulme and Jones 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 in addition to the **season of birth**. 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 year differed from the long-term rainfall conditions in the department. It is measured as the ratio of the mean rainfall over the year to the mean rainfall over the 1970-1998 period.

An interaction term of these two variables is introduced in the model. Overall, the influence of drought on the risk of death is actually expected to be higher in drier agro-climatic regions than in wetter regions and the effect of rainfall surplus is expected to be higher in wetter agro-climatic regions than in drier regions where an increase of rains may provide inputs to farm production and sources of water (Balk et al., 2004).

Finally, a fourth variable (monthly deviation) indicates the **extent to which rainfall in the department differed over the month of child observation** from the long-term rainfall conditions in the department for the same month. The measure is the ratio of the rainfall over the month of child observation to the mean monthly rainfall over the 1970–1998 period.

Methods

Event-history methods are used to estimate the impact of the rainfall on child survival, controlling for relevant variables related to the child (sex, rank, generation) and his/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, such as rainfall variables. More precisely, it is possible to take into account the conditions of the child environment during his/her first five years and not only at the time of the survey, as has generally been done by previous studies.

Results and Discussion

A previous analysis has already highlighted how child survival is related to specific patterns of rainfall variations in each region of Burkina Faso (Dos Santos and Henry 2008). The more contrasting results come from the interaction term of the yearly deviation and the long-term average rainfall. In Burkina Faso, specific patterns of rainfall variations and child mortality

relationships in each agro-climatic region. A rainfall deficit increases child mortality in the more vulnerable regions (500-699mm). At the opposite, a rainfall deficit reduces child mortality in wetter regions. In the first case, crops are more sensitive to environmental variations, while in the second case, rainfall limit the development of pathogens.

However in Mali there are no specific patterns in each agro-climatic region: in all regions, risk of dying is reduced with abundant rainfall (Henry and Dos Santos 2008).

Explanations of these unexpected and contrasting results could be find in the death causes differentials and more generally in specificities in the health system of these two countries (i.e. variations in geographical access to health services, immunization rates).

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