Using Agent-Based Modeling to Understand the Impact of HIV/AIDS in the Context of Socio-Economic Stressors

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Abstract

In this paper, we present an agent-based simulation model of the social impacts of HIV/AIDS in villages in the Sekhukhune district of the Limpopo province in South Africa. HIV/AIDS is a major concern in South Africa, not just in terms of disease spread but also in terms of its impact on society and economic development. The impact of the disease cannot however be considered in isolation from other stresses, such as food insecurity, high climate variability, market fluctuations and variations in support from government and non-government sources. The model described in this paper focuses on decisions made at the individual and household level, based upon evidence from detailed case studies, and the different types of networks between these players that influence their decision making. Key to the model is that these networks are dynamic and co-evolving, something that has rarely been considered in social network analysis. The results presented here demonstrate how this type of simulation can aid better understanding of this complex interplay of issues. In turn, we hope that this will prove to be a powerful tool for policy development.

1 Introduction

If you are only interested in epidemiological models, that is not this paper's primary objective. Neither does it focus only on how a pandemic, in this case HIV/AIDS, spreads in a region. Instead, this paper looks at the issue of how HIV/AIDS influences the livelihood and the household structure of a rural community in South Africa. We do this by presenting an evidence-based model of the interplay of social processes and the effects of the resulting networks of individuals and households in the community. This model, developed using data from field work surveys and interviews in the Limpopo province in South Africa, demonstrates how a social simulation model can be helpful in understanding the impact of policy change.

Research in the socioeconomic impact of HIV/AIDS has become a top agenda of the United Nations and other non-government organizations (NGOs) over the last few years [8]. In South Africa the epidemic has evolved at an astounding rate, rising from a prevalence of less than 1% among adults to almost 25% within ten years. A recent study shows the devastating toll AIDS is taking on human lives: from 1997 to 2002 the death rate increased by 62%\(^1\). However the impact of HIV/AIDS cannot be measured in terms of the death rate alone: one of the major concerns is that the nature of the disease means that those most likely to be infected are the young sexually-active adults. This means that communities become skewed, with relatively large numbers of children and elderly, and relatively few fit, strong and productive members. It is therefore necessary to investigate this impact of HIV/AIDS at the communal level [5].

Agent-based social simulation is a tool well suited for an investigation of this sort since it allows for the necessary detail in modeling the effects of stressors like HIV/AIDS on social networks. Unlike conventional epidemiological models that operate on the level of whole populations and therefore con-

\(^1\)http://data.unaids.org/Publications/Fact-Sheets04/FS_SubSaharanAfrica_Nov05_en.pdf
centrate on ‘average’ behavior, agent-based models can take the actual behaviors of individuals into account. This is a prerequisite for investigating impacts on social networks and communities. Over the last few years, this has been recognized by the life science community concerned with modeling the HIV/AIDS epidemic. However, even though HIV/AIDS is a key concern, its impact in South Africa cannot be examined in isolation of other stressors, such as food insecurity, high climate variability, market fluctuations, and poor governance [22].

In this paper, we present a model that captures socioeconomic stressors experienced by the villagers in the Sekhukhune district, Limpopo Province, South Africa. The model has been driven from the evidence made available from our case study team as well as secondary sources. The nature of this evidence is both quantitative as well as based on the anecdotal accounts from the stakeholders. Moss and Edmonds [10] have argued for models developed bottom-up, where the available evidence is not ignored for simplicity’s sake. We believe a model’s purpose in social simulation is to enhance, if possible, our understanding of the underlying problem. It can be helpful to the policymakers and stakeholders in designing better policies when there is a fairly acceptable representation of the social processes in the model. Our model is fairly descriptive in nature and may be presented as an example of the KIDS (keep it descriptive, stupid) modeling technique [4]. We have relied on a number of assumptions as well, like any other model, when direct evidence is not available. Where such assumptions have been made, the choices have been discussed with our case study team and are also subject to verification through ongoing fieldwork.

The rest of the paper is structured as follows: Section 2 discusses the case study region which is located in the Limpopo Province in South Africa. It focuses on the endogenous and external socioeconomic drivers that affect people’s lives. Section 3 describes the model we have developed while section 4 presents the dynamic behavior of the model. This is followed by a selection of specific scenarios and discussion of their simulation results in section 5. Finally, conclusions drawn from our work so far and future perspectives are presented.

2 Case Study

The case study for this work focuses on the Sekhukhuneland area, a cross-border district occupying the northern part of Mpumalanga and the mid-southern part of Limpopo Province. The area is mainly rural, located approximately 200km northeast of Pretoria. In the case study area, there are a range of stressors to which people are exposed, including water scarcity, climate variability, HIV/AIDS and food insecurity, leading to high vulnerability [22, 23].

The population in the case study area is highly reliant on state grants such as pensions or child/orphan grants, as well as money that is sent home from family members who have migrated to other areas for work. Although this is a predominantly rural area, agriculture alone is insufficient for the population’s needs. In fact, recent reports show that most people have stopped taking part in agriculture at all because problems with water supply can mean that the cost of growing crops is greater than the return. Death of a family member receiving a grant or sending money home can therefore have a devastating effect on a household.

The nature of HIV/AIDS means that the population has a high number of orphan children. Households typically consist of more than just a typical nuclear family, but nevertheless there are times at which a household is left with no adult members. In such situations, orphan children are usually accommodated by a household within the extended family.

With regards to social policy and its applications, the above-mentioned issues need to be tackled both at the national and the district levels. The former concerns the implications for food and basic amenities subsidies for the local districts, whereas authorities at the district level are often interested in the distribution of available resources to the village people and efforts towards sustainability of the households. Many of the social networks in this area operate at the household level rather than the individual level, and pooling of finances, mutual help and resource-sharing among members are the basis of these networks. Such networks are dynamic in the sense that existing households in the community disintegrate and new ones are created. Consequently, relationships between the members of the networks change over time. The dynam-
ics of the social networks result from the interplay of both exogenous and endogenous processes mentioned above.

Water scarcity constrains not only field-based agriculture, livestock and home gardens but also development projects such as brick-making etc. A large dam has been planned in the region, and construction is expected to start this year, yet there are environmental concerns about it. Another key stress in the area is unemployment. Over 90% of the population live in rural areas and there are very few jobs in the villages [23]. People therefore tend to migrate to urban areas to find employment. This is often regulated by social networks, as people migrate to areas where they have friends or family with whom they can stay while they are looking for work. Mines in the region also provide employment opportunities, although they have associated costs. Many of the jobs at the mines require particular skills which are not available in the local population. This means that there is a consequent inward migration to the region, and associated with this is a concern that there is an increased risk of HIV/AIDS spread.

Much of the data used to develop this model has been supplied by our fieldwork team on this project. They have been involved in a series of surveys and interviews with residents in the region over a number of years, and this work is ongoing. Additional data has been provided by RADAR, an organization working in the same region. Through their work, the RADAR team have acquired extensive data concerning household compositions, people’s affiliation to various organizations and safety-net schemes, and data related to individual and household-level characteristics. We have also made use of the existing literature and external references. The next section discusses the way in which we have used this data to construct our model, as well as further details of the context of our case study.

3 Model Specification

The agents in our model represent individuals in the case study. Networks within the model emerge both at the individual level and also at the household level, where a household is a group of individual agents in which a single agent typically takes responsibility for decisions at this level. The model thus attempts to take into account both the individual interactions and the dynamics between households. It has been implemented in Java, making use of both the Repast\(^2\) toolkit and Jess\(^3\). Pajek\(^4\) has also been used to visualize the results. Time in the model progresses in monthly steps, and typical scenarios extend over many years.

### 3.1 Individual agents

Agents in the model represent individuals who are characterized by their gender, age group, marital status, health status and expected normal age. Agents are created at the start of the simulation run, and further agents may be born during the run of the simulation. The agents age as the simulation proceeds and become involved in the social processes individually as well as collectively. Table 1 illustrates the basic attributes of an agent in the model.

#### 3.1.1 HIV/AIDS spread

One of the key individual-based processes in our model is the spread of HIV/AIDS. One way of modeling this spread would be to model the sexual activities of agents, however this is both a socially and politically sensitive topic for which it would be inappropriate to model.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Possible values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>female; male</td>
</tr>
<tr>
<td>Age Group</td>
<td>child [0-16 years); adult [16-45); senior [46-onwards]</td>
</tr>
<tr>
<td>Marital Status</td>
<td>single; married; widowed</td>
</tr>
<tr>
<td>Health Status</td>
<td>well/ok; HIV/AIDS; old age sickness; disabled</td>
</tr>
<tr>
<td>Expected Age</td>
<td>Sampled from Normal Dist with values of mean expected age (56 years) and standard deviation (10 years), as taken from the available demographic data.</td>
</tr>
<tr>
<td>Hunger Status</td>
<td>fully fed; half fed; not fed</td>
</tr>
</tbody>
</table>

\(^2\)http://repast.sourceforge.net/

\(^3\)http://www.jessrules.com/jess/

\(^4\)http://vlado.fmf.uni-lj.si/pub/networks/pajek/
be difficult to gather data (and may indeed interfere with the trust that has been established between our fieldwork team and the subjects of the case study).

Several epidemiological models have addressed the issue of modeling the HIV/AIDS spread in sub-Saharan Africa (for example, [16, 14, 6]). However as the spread of HIV/AIDS is not itself the focus of our work, we have adopted the distribution-based approach of Salomon et al. [14], using the ‘Gamma’ distribution as it was closest to the demography of our case study region.

The effect of migration is significant in the transmission of HIV/AIDS. We know from the fieldwork research that migrant workers visit their spouses every two or three months at the least. As the incidence is used at an annual time scale in the model, an implicit assumption is that if an agent contracts HIV/AIDS, their spouse also becomes infected. Furthermore, around 20-45% of the children born to HIV+ mothers become infected with HIV as well.\(^5\) We have used 30% in our simulations for mother to child transmission. We have also assumed that there is no nevirapine or antiretroviral drugs accessible to the villagers. Although such drugs have been reported to have reduced the risk of HIV to as low as 2%, which obviously has both short and long-term implications, they are not yet available in our case study region.

3.1.2 Agent’s health status

In this model we measure the agent’s health as a proportion of full fitness, as is done in several other models such as those of Werth et al. [20] and Younger [21]. In reality it is difficult to ascribe a concrete number to an individual’s health (such as “X is 56% fit”), and we are aiming for a qualitative rather than quantitative measure of health. At this stage of our work we do not have sufficient data on how exactly this would be modeled however, and are relying on the outcomes of further fieldwork for this refinement.

Modeling an agent’s food and nutritional requirement is important especially as food insecurity and declining health is seen as prime stressors by the stakeholders [9]. In our case, we have introduced a more focused representation of an agent’s food requirement. This is realized by using Adult-Health Equivalent estimates\(^6\), whereby health declines when food needs are not met.

Another significant impact on an agent’s health status is the incidence of HIV/AIDS: a patient’s health decreases more rapidly after the incubation period. As UNAIDS reports [17], the median time from HIV/AIDS infection to death is 8-9 years and this is reflected in our model. To model the decay in health of an infected individual, the Sigmoid (S-) function is used. We consider an incubation period of 18 months on average and a median time of 8-9 years from infection to death.

3.1.3 Births

In the model, children are born to married couples. A birth is possible if both partners are alive, at least one year has passed since the mother last gave birth, and the mother is ‘well.’ The mother is considered to be able to give birth until 8 years (or 96 months) after HIV/AIDS infection. If a new birth is possible according to these rules, it occurs with a fixed chance, set at 30% in our model.

3.1.4 Ability to do labor

An agent’s age and health status determine its ability to participate in labor in the village or to migrate to seek employment. Every adult agent is considered to be suitable for such work so long as its health status is not ‘disabled’ – a status that is triggered if the agent has been infected with HIV/AIDS for three years. However the availability of such work is limited, and so not all able agents receive work. In our model, 40-50% male and 30-40% female agents receive income in this way, and their earnings are sampled from a normal distribution with mean 100 Rand and standard deviation 25 Rand. The proportion of working agents and the value of their income are both assumed from anecdotal accounts – further data gathering is required for more concrete values.

3.2 Households

In the region in which our case study is based, the notion of a ‘household’ is not well-defined. Unlike

\(^5\)See e.g. http://www.avert.org/pregnancy.htm

\(^6\)http://www.fao.org
the typical understanding of a household being either a nuclear family or slightly extended family, there is considerable variation from this picture. Many people in the case study region live together as one household without necessarily having any blood relation at all. People join the households of their relatives or friends, children are sent to relatives’ households during hard times, and orphans are accommodated by relatives and/or neighbors. Households pool and share their resources, and tend to have a single individual who makes the key decisions for the household (such as how to invest savings). These household heads may be male or female, and in the event of the head dying it is usually the spouse who becomes the new head. If the deceased household head had no spouse, one of the other adult members of the household will take over this role.

In our model, a household is defined as several agents (typically but not necessarily related) living together where all income and available resources are pooled and shared. Each household has a head, chosen randomly from the available adults at initialization, and if this head dies the role is taken on either by the deceased’s spouse or some other random adult in the household. This random choice of head probably does not correctly reflect reality, but is used in the absence of further information. The initial configuration of households is a diverse collection of agents typically containing a mixture of married couples, unmarried adults, seniors and children. As the simulation progresses, household composition changes with the birth of children, death of members, and the absorption of unsupported members (that is when there are no remaining adults) into other households. This change in household composition is an important indicator of the effect of stressors.

### 3.2.1 Household income sources

In contrast to many other countries in Africa, South Africa has a social support system which provides grants of various types to the people. The various types of grants provide the main source of income, sufficient in many cases to support an entire household [13, 23, 22]. A significant proportion of the grant money is essentially spent on food. This is followed by transport and medical expenses and for membership fees to various organizations. Three basic types of grants, listed in Table 2 are available.

### Table 2: Available grants

<table>
<thead>
<tr>
<th>Grant type</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child support grant</td>
<td>For children until the age of 7.</td>
</tr>
<tr>
<td>Disability grant</td>
<td>For adults suffering from HIV/AIDS. Not all qualifying adults apply for this grant as there is a social stigma when an individual is known to be infected. Seniors receive this grant, from age 55 for women and age 60 for men.</td>
</tr>
<tr>
<td>Old-age pension</td>
<td></td>
</tr>
</tbody>
</table>

Another significant source of income comes from individuals who have found employment, either within the village and surrounds or who have migrated further afield [11]. Those still living at home will contribute their entire earnings to the household, whereas those who have migrated will send home a proportion of their earnings.

### 3.2.2 Marriage and creation of households

Although several couples may live in the same household, occasionally new households are established when couples marry. For single adults, marriage partners are selected randomly, with the only restrictions being that the selected partner must also be adult, and the incest taboo is observed for the nuclear family. A significant feature of marriage in South Africa is the paying of the bride price (‘lebola’) by the groom to the bride’s family – a value of at least 1000 Rand. Moreover, in order to establish a new household, the households of each partner in the marriage contribute money. If a new household is established, it is considered to be part of the groom’s extended family; if not, the bride joins the groom’s household.

### 3.2.3 Accommodating dissolved households

A key role of an extended family is the accommodation of the dependents of a household when no adults are left to look after them [7, 8]. Strong kinship ties have long been understood as perpetua-
tors against the socioeconomic stressors in the sub-Saharan region [15]. However, it has been a growing concern of stakeholders and funding organizations that this long trusted safety-net is no longer effective against the increased mortality rates brought about by HIV/AIDS. Households have an incentive to accommodate orphans because of the child support grants to which they are entitled. Furthermore, if children are accommodated by another household while their parents migrate for work, these hosting households will receive a share of the parents’ incomes. On the other hand, these potential sources of household income must be balanced against the ability to provide food for the household members.

In our model, this process triggers when no adults or seniors remain in a household. If grandparents of the children exist, the children are accommodated in their household, otherwise they are accommodated in any other household in the extended family. When there is no available household in the extended family, the neighbors accommodate the dependents.

3.2.4 Feeding household members and ‘borrowing’ food

At every time step, the household head agent decides on how the available food is to be distributed among the household members. An alternative model capturing the effects of climate on livelihood in the region [2] did not distinguish between household member types (such as child, adult, senior) and hence assumed that food was distributed evenly between the members. However we know from surveys [13] that adults will try to ensure that children are fed before allocating provisions to themselves, and food scarcity is too crucial an issue in our studies to ignore this.

Depending upon the household’s income for the month, the household head decides how much money will be spent on food. (The other key expenditure is on health costs.) This food is then distributed to the agents in the household, with the children being fed first. Adults who go hungry will, with some probability, attempt to ‘borrow’ food from their friends. Help is provided, if possible, with an expectation of reciprocal action at a later time [23]. In our model the chance of requesting food from friends is set at 25% – a value taken from anecdotal evidence that requires further data.

4 Dynamic Social Networks

The model adopts a multi-relational social network scheme based on two levels of abstraction as described by Alam and Meyer [1]. Two network layers are considered, one on the level of individuals and one on the level of households. The networks discussed in this paper are dynamic in the sense that households may disintegrate, while new ones are created, and the relationships among the members of the networks change over time. In case of networks involving individual agents, ties are built and broken when the agents are born and die during the simulation run.

4.1 Households’ social neighborhood

Households in the model have a social neighborhood space. As actual empirical data on the structure of these networks is a focus of ongoing fieldwork, we have assumed a small-world network. This assumption is supported by several other studies conducted in the region (e.g. [12, 22]). Neighbors provide mutual support through lending food etc. to each other.

The social neighborhood also provides support to orphans and dependants of a dissolved household in case the extended family fails to do so. Figure 1 illustrates the households linked by their social neighborhood.

4.2 Agents’ friendship networks

The model also contains a friendship network comprising of individual agents. Friendship is a symmetric relation. At initialization, no two friends belong to the same household, but this may change over time as the household compositions change (for example due to marriage). We have restricted the friendship network to adult agents. There is an upper limit (5–7) for the number of friends agents may have at initialization, when each agent has a varying number of friends chosen uniform randomly from (0, upper-limit-for-friends). Figure 2 gives a snapshot of the adult agents’ friendship network.
4.3 Extended family network

As discussed earlier the extended family network is crucial to accommodating orphans when there is no one left to look after them. Marriages are the way through which households get connected to the extended family network. Hence, the network may be perceived as overlapping clusters of households.

At the start of the simulation households are initialized with no extended family networks. The households are nevertheless linked via the social neighborhood shown in Figure 1. As the simulation proceeds and marriages occur, the extended family network grows. Alternately one can initialize the model with a pre-existing kinship network. In this case, the model establishes extended family links to households, chosen randomly, where the number of links assigned to each household is a parameter.

4.4 Savings clubs (‘stokvels’)

The social neighbors form the basis for informal savings clubs, known as stokvels. Members of a stokvel pay a mutually agreed sum into the club every month. The cumulative savings of the group are then rotated to each member of the group on a regular basis. After everyone has had their turn in receiving the contributions, the group may disband or start another cycle. Female household heads with higher literacy are usually the coordinators of these savings clubs [18, 5]. We model this by introducing the role of ‘innovators’ for a certain proportion of agents. Innovators are able to initiate a savings club by inviting other agents and run the club after its formation. Figure 3 shows the evolution of savings club memberships over time.
4.5 Funeral clubs

The increasing number of deaths in the sub-Saharan region endangers the community structure. Death of an extended family member constitutes a significant financial burden and in reaction to this, many households belong to funeral clubs. These clubs provide money and other forms of aid to the bereaved families. In contrast to the informal stokvels, funeral clubs are usually institutionalized and may be receiving money from aid agencies. Members of these clubs pay monthly dues. The number of funeral clubs is a parameter in the model and each club is created with initial funds at initialization. Each funeral club membership consists of a star-like network of member households.

4.6 Migration

Migration, according to the stakeholders, is perceived as a long-term coping strategy to stressors [23]. For many stakeholders, it is also considered as the final resort [3, 19, 20]. Having a relative or a friend in a city plays a pivotal role in an individual’s decision to migrate. Social links therefore are central to the process of migration. At initialization, a proportion of the agents are assigned ‘migrated’ status. These networks provide the necessary links to encourage further agents to migrate later on.

The already migrated agents may be unmarried or married and have friends and extended family members in the village. At every time step, adult agents in the village review whether they should migrate or not. They have to be able to do labor (see Section 3.1.4), which is a pre-condition for migration. The agent’s decision to migrate may be defined as follows:

If (there are children in the household)
AND (household members are hungry)
AND (household can afford travel expenditure)
Then (decide to migrate)

Social networks are important for an individual’s migration. Having decided to migrate, an agent looks to their relatives and friends who had migrated earlier on. The two networks, in this case, are quite likely to overlap. We have restricted the number of tries chosen randomly with the number of already migrated agents as the upper limit. This is done because agents have varying and limited access to those already migrated.

5 Simulation Results

The elaborative nature of our model allows it to be run and investigated in numerous ways. The social processes bring the opportunity of exploring a vast range of scenarios concerning HIV/AIDS effect on individuals and communities, impact of government grants, and the interplay of social networks etc. Here we select some scenarios focusing on how far the overlapping nature of social networks helps in coping with the socioeconomic stressors. In all cases the following parameters have remained fixed: starting number of households (100), starting HIV/AIDS prevalence (20%), child birth rate (30%). Initial number of agents in the village ranges from 600 to 900 (an average household consists of 7–10 individuals).

5.1 Role of social networks in accommodating dissolved households

Households depending upon the income of a single member or two are most susceptible to dissolve in case of the breadwinner’s death. Extended family and neighbors are generally expected to accommodate orphans and disabled senior members when there is no one left to look after them. An increase in an accommodating household’s size results in an immense burden on its finances. Within our model’s framework we investigate this phenomenon for slightly different scenarios.

Figure 4 shows five scenarios, each representing a suite of 30 simulation runs. Concentration of extended family relations defines densely, medium and sparsely connected links among households. Relatives being also neighbors provide the best safeguard for orphans and disabled individuals. Strong overlapping of the two modes of households’ networks explains this fact. Nevertheless, this safeguard no longer remains efficient, in the case where the extended family’s role is mitigated. The two bottom series show how the number of accommodating households is affected when only the social neighborhood remains to take care of orphans. In these scenarios we ran simulations with...
two probabilities for initial links in the social neighborhood network: 0.2 (as default) and 0.1, respectively. Contrary to intuition, the less dense small-world setting (i.e. 0.1) performed slightly better than the other one. This can be explained from the fact that network ties and households population evolve as a result of the underlying social processes. The initial small-world network setting for the neighborhood is no indicator for the simulation outcome.

5.2 Impact on household’s composition due to HIV/AIDS and migration

Lack of available labor and income in the village forces adults to migrate in order to raise their living. However, lack of social networks as well as financial constraints can be a hindrance to migration. A major effect of migration on the household is that elderly people (seniors) have to take the responsibility of looking after themselves and the children. In combination with the HIV/AIDS prevalence, the situation becomes even worse. While migration brings remittance and thus better opportunities for the receiving households, it increases the risk of seniors being burdened with household care and thus aggravating health related issues.

Figure 5 summarizes the results of simulation runs addressing the issue of seniors taking over as household heads in the region. The four different scenarios reflect the possible combinations of the two major factors: HIV/AIDS incidence and migration. While AIDS affects an individual’s health, migration of individuals depends upon their household status as well as the availability of their social links. With and without migration, HIV/AIDS prevalence is the primary cause behind seniors taking over as household heads. While migration exacerbates the situation, it alone does not play a very significant role, since without AIDS-related deaths enough capable adults remain in the village.

These scenarios indicate serious policy implications as the government plans to build more mines in the region. Such initiatives may prove as catalysts towards an increase in migration and HIV/AIDS spread.

5.3 Household economy and food intake

Modeling complete household economy for our case-study region is not possible as this requires meticulous fieldwork research. However, the impact of households’ income via remittance on the availability of food can be investigated based on the available evidence. A household head’s primary concern is to feed the household’s members. Memberships in the savings clubs are another indicator of how the household head’s decisions are affected by the monetary situation: People will join savings...
clubs whenever they can afford to pay the monthly fee, and drop out when the household’s income is too low.

Figures 6 and 7 show the reciprocal influences of migration, the agents’ feed status and savings clubs memberships. In each simulation run, we started with 2–3% number of adult migrant workers, with households’ initial income ranging from 500 to 1000 Rand. The amount required for migrating to the city was set as 100 Rand, while the number of funeral clubs was set fixed to be 7. Rather than showing the average number of savings clubs for the simulation runs, Figure 6 presents a sample of 20 runs. The idea behind this is to find out whether the behavior remains consistent with understandable variability or not.

With the number of agents going hungry increasing in Figure 7, households pull out of the savings clubs. This happens either when the head dies or the household’s income is badly affected due to health and funeral expenditures. A declining household economy results in an agent migrating and the remittance contributes towards reducing the number of agents going hungry. However, as HIV/AIDS prevalence increases, both savings clubs and agents’ remittance break down, as can be seen around the 800th simulation month.

6 Conclusion and Outlook

Despite the many studies conducted by social scientists and epidemiologists etc. (a few of which are cited in this paper), applying formal techniques for investigation of socioeconomic stressors in the sub-Sahara is rare. Lives of the individuals have been badly affected due to illness, lack of labor, food scarcity and very importantly by the HIV/AIDS spread. Although the social networks such as friends, extended family or club memberships have helped in coping with the stressors in the recent past, this is no longer the case. Death of an individual may ruin the livelihood of their household and that in turn threatens the existence of the entire community.

The model presented in this paper makes several important contributions. First, it further extends the use of multiagent-based simulations in an area related to social policy design at the individual and household levels. We believe that agent-based sim-
ulation models can contribute towards providing the policy-makers with better understanding of this critical problem. Our model is driven by evidence and is based on real case-study fieldwork, which is uncommon in the area of social simulation.

Further evidence will be made available to us through our case study partners in the course of the project. This will confirm or guide the elimination of assumptions relying on anecdotal accounts and thus further refine our model. We have, however, demonstrated that agent-based modeling of the complex impacts of HIV/AIDS on social networks in rural South Africa is indeed promising. We expect to investigate various policy-related scenarios such as building of dams, mining etc. as next step. This will be carried out with the involvement of the stakeholders and domain experts.

An important contribution of this model is that it captures the notion of cross- and overlapping social networks at different levels in modeling human social systems. Networks in our model are generated through local social processes irrespective of any starting network topology. Analyzing the dynamics of such networks is an interesting problem itself.

References


