

From Demography to Spatial Networks – Revisiting and Extending a Simulation of Hunter-Gatherer Demography

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Motivation

Research about the demography and mobility of hunter-gatherer groups has important implications for the evolution and history of humankind. It not only helps in understanding the movement and dispersion of people, but also the transmission of culture, genes, and diseases.

Both demography and mobility of hunter-gatherers are impacted by their individual social networks. Likewise, these social networks are constituted by demography and mobility.

Existing mobility models used in hunter-gatherer studies often neglect this socially constituted mobility in favor of resource-oriented mobility. Demographic simulations can account for social relations (kinship), but don't have a spatial reference. A complete picture, however, needs a combined approach.

This study aims at integrating demographic and spatial data: A first step is the replication of a simulation of a specific case of hunter-gatherer demography called AMBUSH. In a second step, the simulation will use the kinship links generated by the demographic processes as providing options for the movements of individuals and families.

Band and Individual Mobility

The Dobe !Kung live in Botswana, at the western fringe of the Kalahari in a brush scrub desert with a seasonal change of dry and rainy periods. During the dry periods, water can only be found at a few permanent waterholes, where people gather during that time, only to spread out in smaller groups into the surrounding area during the rainy season.

In the 1970s John E. Yellen observed that the composition of these dry season camps varies substantially from year to year with individual peoples or families attending different waterholes over the years.

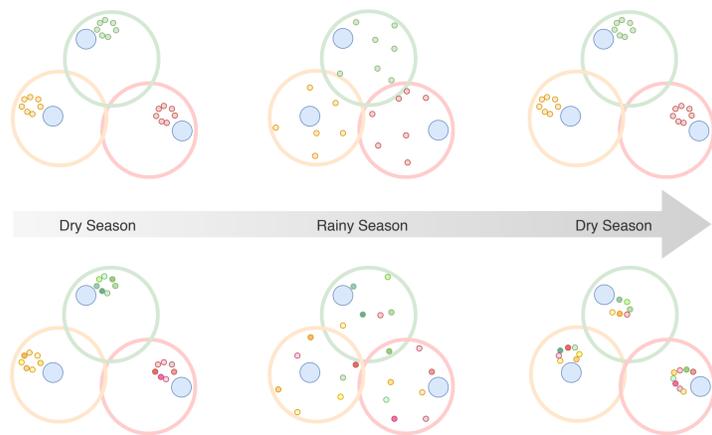


Fig. 1: Model of Band vs. Individual Mobility

This diagram shows possible locations of individuals or families (small colored dots) from one dry season to another. Blue dots represent permanent waterholes. The colored circles mark band territories: the area where the members of the band are supposed to roam. The first succession shows mobility according to the „band model“ described by Richard Lee. The second succession shows the mobility of individuals or families.

References
 Howell, Nancy, and Victor A. Lehotay (1978) Ambush: A Computer Program for Stochastic Microsimulation of Small Human Populations. *American Anthropologist* 80(4): 905–922.
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Relatives as Resources

While the composition of a single camp changes from year to year, genealogical data show that its inhabitants are related to one another by kinship. It is these relationships that provided people with various opportunities and motivation for movements: an underlying network separate from the distribution of natural resources (normally considered the main determinant of mobility). This network changes over time and has i.e. different peaks for both sexes due to specific marriage patterns.

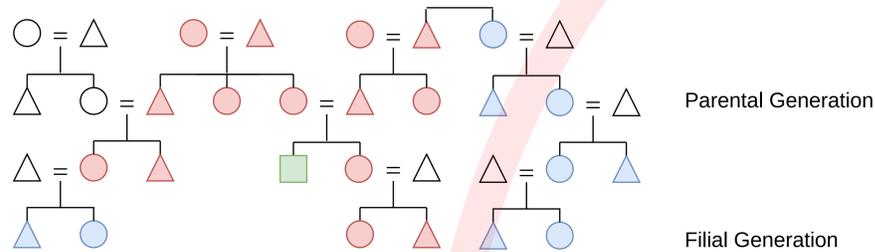


Fig. 2: !Kung Marriage System

The green icon marks ego. The red icons mark individuals who are excluded as marriage partners. Blue icons mark individuals that are descendants of grandparents' siblings, which are allowed but not preferred as marriage partners. Not included here are restrictions due to naming relations, that is to persons with the same name as ego

Revisiting Ambush

While kinship is culturally defined, it is entangled with demographic features. The Demography of the Dobe !Kung was the subject of a seminal study by Nancy Howell (1979). Together with Victor Lehotay, she developed a simulation called AMBUSH to check the validity of her data and to explore relations not easily observable in reality.

One of the biggest obstacles for the generalization of Howell's data, and also one important outcome, has been high fluctuations in demographic measurements (like population size) due to the small group size.

Since the original version was written in an obsolete programming language, I have created a replication in a programming language specifically designed for simulations. For this I used the specifications provided by Howell and Lehotay. However, some discrepancies between the outcomes of the simulations persist, which need to be further examined.

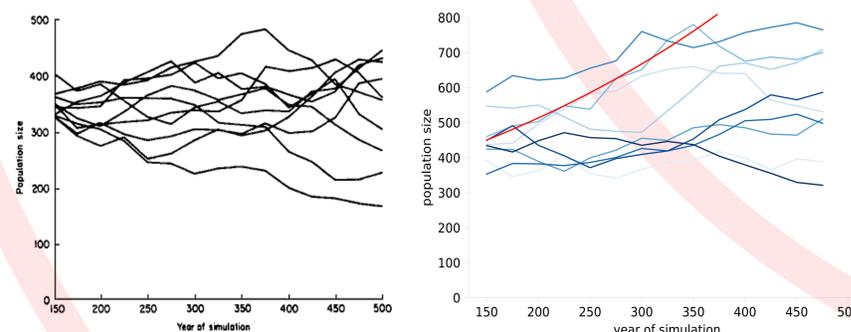


Fig. 3: Population Dynamics in the original AMBUSH (left) and the replication

Single lines represent single simulation runs (see Howell 1979, Fig. 14.1). Note the different scaling of the plots. The red line is the intrinsic rate of natural increase, which Howell calculated as 0.00263 (Howell 1979:215). Beside fertility and mortality schedules the fluctuations result from the availability of spouses. As can be seen, both simulations generate viable populations. However, the spread in population sizes is much larger in the replication, as is the overall growth.

On the Move

The next step will be the integration of a spatial dimension in the demographic model in order to develop a model of mobility based on social relations.

Individuals will be located at waterholes in a simulated environment resembling the Dobe area. The simulation will include spatial preferences in marriage choices and post-marital residence rules. As the kinship ties spread, so do the opportunities for individuals to join camps at other waterholes. The structure of the networks during different phases of population growth and decline can be explored, as well as the effects of different patterns and densities of waterholes.

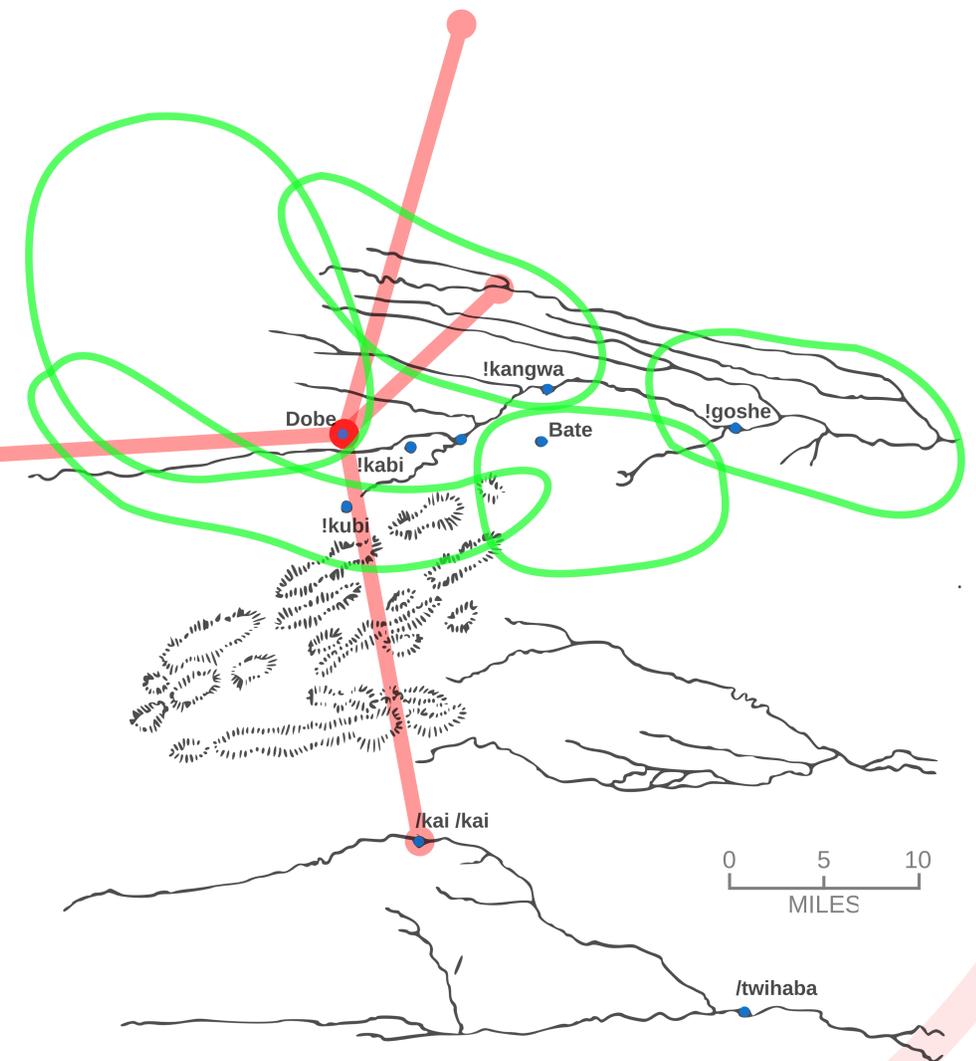


Fig. 4: Territory vs. Social Network

This depicts different conceptions of mobility: the band level and the individual or family level. Green areas mark the band territories described by R. Lee (1965). Red lines show individual or family ties to other camps described by J. Yellen (1977). The red circles show the average and maximal distance of the birth place of spouses (41 miles and 142 miles respectively, *ibid.*). The distances and areas covered become much larger. The network connects distant parts of the country.