Human Sociogeophysics — Phase II
The Diffusion of Human Ethnicity by Remixing

Iberall, A., Prof., School of Engineering, University of California, Los Angeles, CA 90024, USA

Abstract: The spread of the species, man, on the surface of the earth has been described physically in two initial phases. In a first phase, 40,000—15,000 ybp, man spread to occupy all of the temperate and periglacial regions of the earth as a constant density occupational expansion of about 0.04 persons per sqkm. As of 15,000 ybp, the population might be estimated to be about 4 million, the birth (and death) rate to be about 0.03 per year, and the Malthusian constant (the net increase of population — birth minus death rate) to be about 0.0002 per year. This phase represented a diffusion of ethnicity (breeding populations) with little remixing. In a subsequent second phase, e.g., 15,000—2,000 ybp, through the Mesolithic, Neolithic, and post-Neolithic phases, while condensations to agriculture and to civilizations took place, even though the population grew to about 180 million with considerable remixing, the Malthusian constant effectively did not change. Thermodynamically (that is as the irreversible thermodynamics of a hydrodynamic field), this result suggests that the persisting demography of a viable species has to be driven by a positive definite Malthusian growth constant beyond a zero thermodynamic equilibrium. It is also suggested that if that constant is globally zero or negative, the species will die. The possible existence of various stability regions (transformations in dynamic states) is also implied.

Introduction — the Constant Density Phase I Expansion

In (Iberall, Wilkinson 1984), we outlined the first phase expansion of man *homo sapiens sapiens* over much of the life of the subspecies, from 40,000—15,000/12,000 ybp (years before present). We characterized it as a near constant density expansion at the unit density value of 0.04 person per sqkm.

It was possible, from the data presented therein, plus some common knowledge and a few simple ideas, to reason physically-physiologically to an estimate for a most important sociophysical quantity, the net rate of change of population (birth rate minus death rate), whose specific measure we call the Malthusian constant.

The Malthusian constant is the net percentage growth rate of a human population per year. The contemporary human population has recently grown at a net rate of 2 % a year; but it is generally conceded that such rates are biohistorically a recent, probably a transient phenomenon, unsuitable for relating to prehistoric rates of growth.

The assumption of an extended period of constant density human expansion, however, offers a more acceptable source for a biohistorical estimate. We summarize the following (drawn from the description in Iberall, Wilkinson 1984), in the spirit of a “back-of-the-envelope” physicist’s calculation.

Earth’s surface area is about 500 million sqkm (13,0002 π km2); of this, about 150 million sqkm (one third) is land surface, of which approximately 100 million sqkm lies outside of the deep arctic regions and is “available” for human habitation.

The adult weight of man (the male value) is about 70 kg. An appropriate maintainable mean traveling speed for a 70 kg mammal would be 6 km/hr. An appropriate maximum daily roaming range for an omnivorous mammal with such a speed is about 30 km.

Therefore, an appropriate group range (habitat) for a hunter-gatherer band of such mammals is 302 π sqkm, say about 2500 sqkm.

Given the assumed effective population density of 0.04 person/sqkm, an appropriate hunter-gatherer band size...
is 100 persons. The given population density of 0.04 per sqkm yields, on a 100 million sqkm land surface, a total nominal near-equilibrium population of 4 million people in perhaps 40,000 bands.

Next we estimate the mortality characteristics of this roaming hunter-gatherer mammal: specifically, the relation between its lifespan and its life expectancy. The human lifespan, about 90 years, is appropriate to a 70 kg mammal. Estimating human life expectancy requires a small note.

Some sources of mortality are age-dependent, others not. The mortality rate \( M \) will be determined by a Gompertzian mortality relation \( \ln M = a + bA \) where \( A \) is age, \( b \) the age-mortality coefficient, and \( a \) the non-age-related mortality coefficient. In protected civil society, the constant \( a \) is small. In the wild (for humans, in the hunter-gatherer society), \( a \) is so large as to swamp \( bA \).

The new occupation of 25,000 sqkm per year at an effective density of 0.04 per sqkm suggests a final net growth of population of 1000 persons per year. An average net growth of the human population by 1000 persons/year, when compared with the final earth's nominal unmixed population of 4 million, implies a Malthusian constant (birthrate less deathrate) of 1000/4,000,000,000 = 0.025 % a year, about one one-hundredth of the contemporary growth rate.

The Malthusian constant \( K \) loosely is also a reciprocal measure of the "doubling time", \( D = \ln 2 / K \). Thus the doubling time of the expanding human population was about 7/0.00025, on the order of 3000 years. This may be compared with doubling times on the order of a generation among many contemporary populations.

We assumed that there was little remixing among separated ethnic groups up to and during the final phase of human expansion, and that remixing did not become a significant aspect until a second period of settlement, i.e., during what has become known as the Mesolithic, Neolithic, and post-Neolithic periods of culture. We are ready to pursue our physical story of settlement into this second remixing phase. With the initial occupation of suitable habitat completed, some change had to ensue. It might have been in the birth and death rate components of the Malthusian constant, in the population density, or in life style. We intend to use the Malthusian constant to probe at the nature of the change.

Second Phase Growth

We now attempt a simplified physical characterization of the global sociocultural field during what we shall call the second phase growth of the human population, the population increase during the period from 15,000 ybp to say 6,000–5,000 ybp (the period of creation of urban civilizations). We shall ground this, however, upon an estimate in round numbers of the Malthusian constant for a somewhat longer 12,000 year period — roughly 14,000–2,000 ybp — because it is only as of 2000 years ago that we have good estimates of local population for two large land areas, the Han and Roman empires. The better estimate is obtained from the first census of the Han. A comparable (but somewhat smaller) estimate is available for the Roman empire at its peak. Loosely (to one significant figure) both empires had populations on the order of 60 million and land areas on the order of 5 million sqkm. Thus, their average density was on the order of 12 persons per sqkm (McEvedy, Jones 1978).

Judging from urban civilizations, e.g., current distributions in the United States, we are aware that one finds spike-like population density distributions for urban areas and very low density distributions for rural counties outside the cities. Population density distributions around the urban spikes tend to fall off exponentially (Hassler 1977). To take the average density of these empires as the average...