GLOBAL DEMOGRAPHY HISTORICAL LESSONS

The second edition

Boris Sedunov

Introduction

This article was published at the www.eni.edu site in 1998. I am using the possibility to express my gratitude to Dr. George Wolford, the EarthNet Institute president for its publication. The last two years could not diminish noticeably the threat of the Earth overpopulation. Just open the http://www.hyperlinker.com/spg/pop.htm site and hear the population bomb alarm clock ticking. Every second the limited Global natural resource is cut to give a share for the three new human beings, who possess all rights to require their part of a common pie. This irresponsible behavior of the current Humankind leaves no chances for future generations to survive on the deserted planet.

Today every educated person on Earth is worrying about ecological problem. Many people connect it with bad technologies, lack of culture, egoistic behavior of businesses and consumers. Surely, all these factors are responsible for the ecology. ***But the real mechanism of the ecology deterioration is unseen for the public opinion. And this mechanism is - the global population explosion.*** However, the demography is neglected by mass media because many nations, religion group, countries, families egoistically think: “We are not so multiple, as compared to our competitors”.

Eight years have passed after the famous book ”Beyond the limits. Confronting global collapse. Envisioning a sustainable future” of Donella H. Meadows, Dennis L. Meadows and Jorgen Randers was published. The book once more attracted the Humankind’s attention to the problem of the global demography explosion and the Earth natural resources exhaustion. But last eight years gave another 13% addition to the global population, that is around 700 million extra people. The importance of the problem is growing with every year, but the ***public attention to demography is not serious enough as compared to the danger of the irreversible environmental catastrophe.***

Internet shows a remarkable illustration of the quite opposite approaches to the trends in the human future - the bet of the famous scientists from Stanford's Department of Biological Sciences, ecologist Paul R. Ehrlich and climatologist Stephen H. Schneider, against Julian Simon, a professor of business administration at the University of Maryland, on 15 current trends whose direction is not positive now, that each will get worse during ten years in future. It is interesting to note, that professor Simon, like Karl Marx in his critics of the Malthus theory, supposes an infinite growth in the Earth resources and productivity.

The main goal of this publication is to give professional and future demographers and ecologists a new tool and new units of measure to estimate mutual influence of the population growth on the cultural, technological and ecological changes. This tool, like a telescope, helps to interpret the Humankind history on the basis of demographic data. Looking forward, this tool helps to make predictions of future changes in our civilization. The key point of the suggested theory is: ***anytime, when the global population growth tends to infinity, the Humankind civilization suffers an abrupt change in all basic aspects.***

1. The Earth population hyperbolic growth law

In spite of overall opinion that the global population grows according to the exponential law, the facts show a more rapidly growing hyperbolic law. ***Hyperbolic law means, that population grows inversely proportional to the time left till some crisis point in a future.*** Among Russian physicists this knowledge originates from the book "Universe, Life, Reason", written by the famous astrophysicist Joseph Shklovsky. He discussed this problem in coordination with the results of the Club of Rome first report. But according to the modern demographic publications the hyperbolic law is not used as a tool in the demographic theory.

Looking at the constant of proportionality in this law, one can notice that its dimension is one of the labor. But what labor could it be? The answer is - it is the labor spent by all people of the Globe to double the ecological niche.

The Earth human population known data for different times show several long intervals in history with hyperbolic population growth law. The most precise data are available for some last centuries. During the period from 1700 till 1960 with the highest precision holds an empirical hyperbolic growth law:

$$N = L / (Tc - t), \qquad (1)$$

where N - the global population number at time t,

Tc - a point of crisis in a future time, such as: the closer we are coming to it, the more the population number, given by (1), tends to grow to infinity,

L - a labor constant, showing a labor amount needed to double the Humankind ecological niche by the new life supporting technologies invention and their wide implementation.

The equation (1) parameters can be found for any two moments of time, t_1 and t_2, for which the population numbers N_1 and N_2 are known. First, we can find the current hyperbolic doubling period, T_2:

$$T_2 = (t_2 - t_1) * N_1/(N2 - N_1). \qquad (2)$$

(It should be noticed, that for an exponential growth law this formula gives the time constant τ instead of the doubling period T_{2e}, that are connected as $\tau = T_{2e} /\ln 2$).

Then we find the crisis point Tc and the labor constant L:

$$Tc = t_2 + T_2, \qquad (3)$$

$$L = N_2 * T_2. \qquad (4)$$

The table 1 shows how the parameters T_2, L and Tc change during the history. It was not easy to collect data for this table. Different sources give different figures. Some data about population values have been taken from the book of D. Stempell, Weltbevolkerung 2000, Urania-Verlag, Leipzig-Jena-Berlin, 1985. Some are taken from the Worldwatch Institute's Reports "State of the World", edited by Lester R. Brown. The very last number is estimated on the basis of the current population number taken from the Hyperlinker Internet page. Surely, for the last lines in the table it is not enough to give round figures for population or to point out only a year, without months. For better precision one should take precise figures estimated for a selected date of the year. But it can not change the general rules resulting from this table analysis.

Table 1.

Hyperbolic law demographic parameters during the Humankind history

Year	Population, mln.	Doubling period, or time constant, years	Crisis point	Labor constant, blns men*year
t	N	T_2 (H), τ (E)	T_c	L
- 8 Th.	7			
0	230	250	250	58
1000	288	4000	5000	1100
1400	380	1250	2650	480
1600	480	760	2360	365
1700	550	685	2385	377
1800	880	167	1967	147
1850	1200	138	1988	165
1900	1600	150	2050	240
1910	1700	160	2070	272
1920	1840	121	2041	223
1930	2000	115	2045	230
1940	2260	77	2017	174
1950	2500	94	2044	235
1960	3000	50	2010	150
1970	3630	48	2018	173
1980	4380	48	2028	212
1987	5000	49	2036	247
1990	5220	68	2058	355
2000	6100	59	2059	360

The interval from 1700 till 1960 corresponds to the hyperbolic population growth law with the crisis point around 2020 ± 30. For interval from the beginning of the New Era and to 1700 the crisis point comes to 3000 ± 700. After 1700 we can see the growth rate acceleration, that means the labor constant diminishing from 580 ± 200 to 175 ± 50 billions men*year and the crisis point coming nearer on 10 centuries.

After 1960 we see the exponential population growth law with the average time constant τ, equal to 55 years, that corresponds to the doubling period constant T_2 equal to 38 years. This exponential growth law can not last very long because of the Earth Globe limited resources; in the near future this law shall be substituted by a more slow growth law, and then by the population stabilization and, probably, by the population diminishing. It is worth being noticed, that ***the crisis point has shifted***

from 2010 in 1960 to 2059 in 2000. In a near future the crisis point will accelerate its runaway to infinity.

Looking at the Table 1, we can notice the World War II influence both on the doubling time and on the Labor constant. These parameters reflect also the Baby Boom after this war. Relatively small Labor constant in the 18-th century reflects the colonial expansion and the new vegetables, like potato, wide implementation in the Old World.

The Labor constant is a very powerful tool to classify the Humankind history. It diminishes during optimistic periods, when humans possess large possibilities to expand their activity and, hence, population. They need not think too much while expanding. In the gloomy periods it grows, thus reflecting, that people think more then act, having met new barriers for expansion.

1.1. The hyperbolic population growth law properties

1. The return population value 1 / N plot versus time *t* in the limits of the hyperbolic growth law is a straight line, crossing the time axis at some future crisis point, Tc.

Moreover, if we plot the personal share, *r*, of some global natural resource, R, such as air, or water, or dry land, habitable territory versus time, we receive a similar straight line, predicting zero level of the resource personal share at the crisis point Tc:

$$r = R / N = (R / L)(Tc - t).$$

Therefore, we can consider the population hyperbolic growth law as the linear diminishing law for the personal resource share.

2. For any time *t* the time left till the crisis point is equal to the last population doubling period value.

3. For any time *t* the current population number N product by the last population doubling period value gives the labor constant, characterizing this particular hyperbolic growth law. This constant, L, can be considered as the labor amount, needed for the Humankind ecological niche size doubling.

4. An annual population growth is equal to the square of the population value, divided by the labor constant:

$$dN / dt = N^2 / L . \qquad \text{(Hyperbolic)}$$

It leads to proportionality of the annual relative rate dependence from population number:

$$dN / Ndt = N / L , \qquad \text{(Hyperbolic)}$$

in opposite to an exponential one that has the annual relative rate independent on population:

$$dN / dt = N / \tau . \qquad \text{(Exponential)}$$

5. For any time *t* the future doubling period is twice less then the last doubling period.

2. The quadratic resources exhaustion rate law

During this century an annual global electric energy, fertilizers, coal, cars, and many another material and energy consuming products production grows as the square of the Earth population number. A corresponding productivity is

proportional to the first power of the population number. It can be explained as the result of a job place complexity growth along with the population growth.

Really, the population number grows according to the available ecological niche expansion, as the result of the innovation implementation, leading to the growth of the job place complexity. For any new citizen of our Planet it is necessary to provide a modern job place in a wide meaning of these words, that includes:

- well equipped living place, including sanitary and medical services,
- well equipped places for continuous education, entertainment, culture and sport,
- the city engineering systems, power supply, transport, communication, publishing, radio and TV broadcasting means,
- a job place itself and well equipped market places.

In parallel with the job place complexity going up there is a growth of the total material, energy, components consumption not only to create the job place, but to maintain it functional and to up-date it during all person's life. The total job place cost proportionality to the global population value, or more precise to the average population density, can not be proven strictly theoretically. It is an empirical fact, noticed for our century that might have in former times some another but also monotonous dependence on the population density.

Growing as the square of population number annual production results in the same law for the main resources diminishing:

$$R = Ro - K / (Tc - t),$$

that shows that the resources amount reaches zero at some point before the crisis point. This resources total exhaustion point To can be calculated as:

$$To = Tc - (Tc - t)^2 / \Theta.$$

Where Θ - is the time needed to exhaust the initial resource Ro at the constant spending rate.

We can estimate, when will be totally exhausted the resource with a spending rate, corresponding to 100 years for a total exhaustion at the same uniform spending rate. Considering the time left till the crisis point about 30 years, we receive:

$$To = Tc - 9 \text{ years} = t + 21 \text{ year}.$$

It means, that this resource shall be totally exhausted already during 21 year, instead of 100 years at the constant consumption rate.

Certainly, the only essential resource exhaustion will be a powerful inhibiting factor for the further population growth. The fact, that this inhibition gets noticeable much before the crisis point, explains the transition from the hyperbolic to the more slow exponential law, started at 1960, about 60 years before the crisis point. But even the stabilization of the global population number does not remove the resources exhaustion problem. ***A new life supporting technology is needed: based mainly on the renewable resources and minimizing the irreversible consumption of the resources.***

3. The global demography, as the mirror of the technology success and the ecology crisis

According to the Table 1, the Labor constant before the New Era was very small as compared not only to the gloomy Middle Ages, but also to the modern epoch. It means that during the Green Revolution the Humankind possessed large territories good enough for the contemporary agricultural technology. At those times the population growth was supported by the extensive expansion of the agricultural territories. But abrupt jump of the Labor constant witnesses that with a New Era humans met significant difficulties in expanding their ecological niche.

If we consider, what lands were the most populated at the Old Ages, we should recognize that most of them have been converted later into desert. In fact, under the sands of Sahara there are the ruins of the old towns. Formerly rich lands of Egypt are covered with sands now. All territory to the South from the Mediterranean See is now a desert or a semidesert. ***So, we see that optimistic human expansion during the Green Revolution resulted in the largest ecological catastrophe.*** As a reminder of this catastrophe we remember the words: “Greece has been eaten by goats”.

The threat of the desertification hung over people through ages. It stimulated thoughts that running for wealth you may come to hell. These thoughts were put into the foundation of the Christianity and explain a rigid asceticism of the first Christians during the whole millennium. During all period of the Green Revolution the humans stood before the ghost of the crisis point, somewhere around 250 year of the New Era. This point is very close to the last days of the old Rome Empire and to the date of the Christianity conversion into the official religion.

Passing by the crisis point the humans had to change their optimistic philosophy on the pessimistic one. Middle Ages gave people an intensive internal work that prepared a new man capable to move forward the Industrial Revolution. But this process was very long and took about twelve centuries. So, we see that the human activity vector does not diminishes its length, it only changes the direction from the extensive activity to the intensive internal work. We can suppose something similar to the Middle Ages before the Green Revolution: the intensive internal works at almost constant population. This internal work prepared the humans to enter the Green Revolution.

The same problem we are facing now: ***the closer we are coming to the predicted crisis point, the more changes enter all aspects of our civilization***. The Julius Vern’s optimism is being substituted by the ecological pessimism. The thought of the sustainable development inherits the thoughts of the first Christians. And intensification of the internal work now means the transition from the industrial expansion to the global computerization. So, now the vector of our activity tends to change its orientation from the extensive Industrialization to the intensive Informatization.

Any abrupt change in the human civilization puts multiple tasks before the education system. ***Now it is a high time to expand ecology and demography education, preparing specialists capable to deal with the population and ecology catastrophe problems***. It covers a wide range of specialties: new legislation and the World order, new ethics, new energy and resources saving technologies, new education technologies, new computer technologies, new medicine, the ecology control means and recycling technologies, and many, many others.