Ethnic Systems Evolution. Computer Modelling

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An ethnos model based on L.N.Gumilev's ethnogenetic theory has been made. The main idea is to admit that ethnic subsystems interact by means of some sort of energy, which Gumilev called passionarity. So, ethnic system can be described with 7 differential nonlinear equations of the 1st order, each of them is for corresponding subsystem: passionarians (the vivid persons, who are able to inspire people with enthusiasm), subpassionarians (the persons providing destructive activity, anti-social elements), harmonic people (the mass of people), organization, science and technology, culture and art, and landscape.

1 Introduction.

The purpose of this paper is to build a mathematical model of ethnos development, to create the proper program in TURBO PASCAL language, and to make the computer experiments. We based on ideas of well-known historian L. N. Gumilev [1,2]. The notion of passionarity is fundamental here. Let's consider an ethnos as a system of seven subsystems: passionarians (the vivid persons, who are able to inspire people with enthusiasm), subpassionarians (the persons providing destructive activity, anti-social elements), harmonic people (the mass of people), organization (or, less precise, State), science and technology, culture and art, and landscape.

We'll study the development of m ethnic systems $\mathcal{E}_i$ $(i = 1, ..., m)$, and we'll take that theirs subsystems are of numerical *passionarity level*. We denote them by $P_i, S_i, M_i, O_i, T_i, C_i, L_i$ respectively.

The dynamics of history of the interacting ethnoses is described by a system of differencial equations. These equations determine the change rate of the passionarity level for every of the subsystems. The time t (years) is within $[0, 1200]$. The number 1200 is the time of existence of culture-historic type that is connected with the ethnos [3,5].

The history of the ethnos begins at a certain moment $t = 0$ with initial passionarity levels

$$\begin{aligned} P_i|_{t=0} = P_{i0},\ M_i|_{t=0} = M_{i0},\ S_i|_{t=0} = S_{i0}, \\ O_i|_{t=0} = O_{i0},\ C_i|_{t=0} = C_{i0}, L_i|_{t=0} = L_{i0}. \end{aligned} \tag{1.1}$$

At the moment $t = t_1$, the ethnos can be influenced with passionarity stimulus, and passionarity exchange will increase for the subsystems. Let $\pi_i(t)$ be the passionarity stimulus for the ethnos $\mathcal{E}_i$. The kind of the function $\pi_i(t)$ is determined with considerations we suppose reasonable ([1]).

It is clear that evolution of an ethnos can't be described itself, with no influence of other ethnoses.

2 Passionarians.

The passionarity level P_i of the passionarian subsystem is described by the differential equation

$$\frac{dP_i}{dt} = P_{\pi i} + P^{(+)}_{Pi} + P_{Mi} + P^{(+)}_{Si} - P_{Oi} - P_{Wi} - P_{Ei} - P_{Pi} - P^{(-)}_{Si} - P_{Li}. \tag{2.1}$$

Here

2.1.$P_{\pi i} = k_{P\pi i} \cdot \pi_i,\ k_{P\pi i} > 0$ is passionarity stimulus, where $k_{P\pi i}$ is the coefficient for the part of the passionarity stimulus that the passionarians take;

2.2. $P^{(+)}_{Pi} = k^{(+)}_{PPi} \cdot P_i$ is to give birth to passionarians who inherit some passionarity;

2.3.

$$P_{Mi} = k_{PMi} \cdot \chi \left(\text{sign } (\frac{dP_i}{dt}(t-h)) \right) M_i,$$

$$\frac{dP_i}{dt}(t) = 0$$

where $t \leq 0$, $h > 0$ is the fixed number, and χ is the Heaviside function, i.e. $\chi(x) = 1$ or 0 according as $x \geq 0$ or $x < 0$; and

2.4.

$$P_{Si}^{(+)} = k_{PSi}^{(+)} \cdot \chi \left(\text{sign } (\frac{dP_i}{dt}(t-h)) \right) S_i,$$

$$k_{PSi}^{(+)} > 0,$$

$$P_{Si}^{(-)} = k_{PSi}^{(-)} \cdot \chi(t-600)\chi(P_i^0 - P_i)S_i$$

are increases (or decreases) of the passionarian passionarity due to the harmonic people and the subpassionarian subsystems influence. That means that the people support (or counteract, respectively) the passionarians when their passionarity goes up (or down, respectively). Here $k_{PSi}^{(-)}$ is the coefficient of "Philistine" (the name is connected to the subpassionarians' tendency to persecute the best vivid representatives of the ethnos when ethnos goes down ([2, pp.202, 456], [6, p.342]);

2.5. $P_{Oi} = k_{POi} \cdot \chi(k_{POi}P_i)P_i$ is decrease of passionarity due to passionarians' efforts directed to making a basis of State organization of the ethnos [3, pp.32–36];

2.6. $P_{Wi} = \left(\sum_{j \neq i} k_{PWij} \cdot \sigma_{ij} \right) P_i$ is for passionarians' casualties, where k_{PWij} is the coefficient of casualties during a war against ethnos $\mathcal{E}_j$, and σ_{ij} is equal to 1 or 0 according as whether ethnos $\mathcal{E}_i$ is at war with ethnos E_j or not;

2.7. $P_{Ei} = k_{PEi} \cdot \tau_i P_i$ is decrease of passionarity for if the State is of dictatorial or totalitarian type then the passionarians are compelled to live in exile.

$$\tau_i(t) = \begin{cases} 1, & \text{if } \mathcal{E}_i \text{ is of dictatorial or totalitarian type} \\ 0, & \text{otherwise} \end{cases}$$

2.8. The part $P_{Pi} = k_{PPi} \cdot P_i$ is the decrease of passionarity level of passionarians subsystem by internecine struggle of passionarians;

2.9. $P_{Li} = k_{PLi} \cdot P_i$ is the expenditure to a transformation of landscape.

3 Subpassionarians.

The differential equation that describes the passionarity level of the subpassionarian subsystem is

$$\frac{dS_i}{dt} = S_{\pi i} - S_{Pi} - S_{Wi}. \tag{3.1}$$

Here

3.1. $S_{\pi i} = k_{S\pi i} \cdot \pi_i,\ k_{S\pi i} > 0$, is passionarity stimulus;

3.2.

$$S_{Pi} = k_{SPi} \cdot \chi \left(\text{sign } (\frac{dP_i}{dt}(t-h)) \right) S_i,$$

$$k_{SPi} = k_{PSi}^{(+)} \geq 0,$$

is decrease of passionarity that means that the subpassionarians support the passionarians when the last go up;

3.3. $S_{Wi} = \left(\sum_{j \neq i} k_{SWij} \cdot \sigma_{ij} \right) S_i, k_{SWij} > 0$, is for passionarians' casualties, k_{SWij} is the coefficient of casualties during a war against ethnos $\mathcal{E}_j$, and σ_{ij} following from 1.6;

4 Harmonic people.

The differential equation that describes the passionarity level of the harmonic people subsystem is

$$\frac{dM_i}{dt} = M_{\pi i} + M_{TCi} - M_{Pi} - M_{Wi} - M_{Oi} - M_{Li}, \tag{4.1}$$

where

4.1. $M_{\pi i} = k_{M\pi i} \cdot \pi_i$ is passionarity stimulus;

4.2. $M_{TCi} = \sum_{j=1}^{m}(k_{MTij} \cdot T_j + k_{MCij} \cdot C_i)$ is the passionarity taken from the science and art subsystems of any ethnos, that is to educate the mass of people;

4.3.

$$M_{Pi} = k_{MPi} \cdot \chi\left(\text{sign }(\frac{dP_i}{dt}(t-h))\right) M_i,$$

$$k_{MPi} = k_{PMi},$$

is decrease of the harmonic people passionarity, that means that the people support the passionarians when their passionarity goes up (or down, respectively);

4.4. $M_{Wi} = \left(\sum_{j\neq i} k_{MWij} \cdot \sigma_{ij}\right) M_i$ is for harmonic people's casualties, k_{MWij} is the coefficient of casualties during a war against ethnos $\mathcal{E}_j$, and σ_{ij} following from 1.6;

4.5. $M_{Oi} = k_{MOi} \cdot \chi(O_i^0 - O_i)\chi(600 - t)M_i$ is decrease of the passionarity that is to strengthen the State by restricting rights of the people in order to make a powerful centralized government system (like the serfdom in Russia) [4, p.112]; this efforts are supposed to be within the first half of ethnos' life (600 years), when the passionarity level of the organization subsystem is low, $O_i < O_i^0$;

4.6. $M_{Li} = k_{MLi} \cdot M_i$ is the expenditure to a transformation of landscape.

Remark. According to L. N. Gumilev the harmonic people have zero passionarity by definition. We depart from this view here, for the harmonic people are the bulk of the members of an ethnos.

5 Organization.

Every of the ethnoses makes his own self-government system which can mean State organization or so. The organization can be made with passionarians' efforts or by restricting civil liberties or by something else. The differential equation that describes the passionarity level of the organization subsystem is

$$\frac{dO_i}{dt} = O_{Pi} + O_{Mi}^{(+)} + O_{WPi} + O_{WMi} + O_{WOi}^{(+)} + O_{Li} -$$

$$- O_{WOi}^{(-)} - O_{Mi}^{(-)} - O_{Ti}^1 - O_{Ci}^1 - O_{Ti}^2 - O_{Ci}^2. \tag{5.1}$$

Here

5.1. $O_{Pi} = P_{Oi}$ is passionarians' efforts directed to making State system;

5.2. $O_{Mi}^{(+)} = M_{Oi}$ is increase of passionarity by enslaving the people;

5.3. $O_{WP_i} = \sum_{j\neq i} k_{PWji} \cdot \sigma_{ij} P_j$ is increase of passionarity when the passionarians of the ethnos $\mathcal{E}_j$ are going to ruin at war with the ethnos $\mathcal{E}_i$.

5.4. $O_{WMi} = \sum_{j\neq i} k_{SWji} \cdot \sigma_{ij} M_j$ is increase of passionarity when the subpassionarians of the ethnos $\mathcal{E}_j$ are going to ruin at war with the ethnos $\mathcal{E}_i$.

5.5.

$$O_{WOi}^{(+)} = \sum_{j\neq i} k_{OWOij}^{(+)} \cdot \sigma_{ij}\chi(M_i - M_j)\chi(P_i - P_j)\chi(O_i - O_i)O_j$$

is increase of passionarity in case of gaining the victory by ethnos $\mathcal{E}_i$ over the ethnos $\mathcal{E}_j$ at war. The conditions of victory are higher passionarity level of the passionarian and harmonic people subsystems of the ethnos $\mathcal{E}_i$ (i.e. higher military spirit of the ethnos $\mathcal{E}_i$), and higher organization level of the ethnos $\mathcal{E}_i$;

5.6.

$$O_{WOi}^{(-)} = \sum_{j\neq i} k_{OWOij}^{(-)} \cdot \sigma_{ij}\chi(M_j - M_i)\chi(P_j - P_i)\chi(O_j - O_i)O_i$$

is decrease of passionarity in case of loosing, respectively.

5.7. $O_{Mi}^{(-)} = k_{OMi} \cdot \chi(O_i - O_i^1)\chi(t-600)O_i$ is decrease of passionarity within the second half of ethnos' life (after 600 years) if the organization system is of high enough passionarity level $O_i > O_i^1$. That means that the people desire for freedom and extention their civil liberties ([4, p.112]);

5.8. $O_{Li} = L_{Oi}$ is increase of passionarity, for the landscape subsystem influence upon the type of ethnos organization;

5.9. $O_{Ti}^1 = k_{OTi}^1 \cdot \chi(O_i - O_i^1)O_i$ is supporting the science by the government if passionarity level of the organization subsystem is high enough $(O_i > O_i^1)$;

5.10. $O_{Ti}^2 = k_{OTi}^2 \cdot \tau_i O_i$ is decrease of passionarity used for persecuting some scientific researches, if the State is of dictatorial or totalitarian type;

5.11. $O_{Ci} = k_{OCi}^1 \cdot O_i$ is support the culture by the State;

5.12. $O_{Ci}^2 = k_{OCi}^2 \cdot \tau_i O_i$ is decrease of passionarity used for persecuting some or other kind of art, if the State is of dictatorial or totalitarian type;

6 Science and technology.

The dynamics of the passionarity level of the science and technology subsystem are described by the differential equation

$$\frac{dT_i}{dt} = T_{Pi} + T_{Oi}^{(+)} - T_{Oi}^{(-)} - T_{Mi}, \tag{6.1}$$

where:

6.1. $T_{Pi} = \sum_{j=1}^m k_{TPji} \cdot P_j$ is increase of passionarity due to scientific activity of passionarians of every ethnos. The coefficient k_{OPij} shows the contribution to the development of the science and technology of the ethnos $\mathcal{E}_i$ by the ethnos $\mathcal{E}_j$;

6.2. $T_{Oi}^{(+)} = k_{TOi}^{(+)} \cdot \chi(O_i - O_i^1)O_i,\ \ k_{TOi}^{(+)} = k_{OTi}^1$ is support the science by the State, if the passionarity level of the organization subsystem is high enough $(O_i > O_i^1)$;

6.3. $T_{Oi}^{(-)} = k_{TOi}^{(-)} \cdot \tau_i O_i,\ \ k_{TOi}^{(-)} = k_{OTi}^2$ is decrease of passionarity, for some scientific researches are persecuted, if the State is of dictatorial or totalitarian type;

6.4. $T_{Mi} = \sum_{j=1}^m k_{TMij} \cdot T_i$ is decrease of science passionarity used to educate the people of every ethnos;

7 Culture and art.

The dynamics of the passionarity level of the science and technology subsystem are described by the equation

$$\frac{dC_i}{dt} = C_{Pi} + C_{Ci} + C_{Oi}^{(+)} + C_{Li} - C_{Oi}^{(-)} - C_{Mi}. \tag{7.1}$$

Here

7.1. $C_{Pi} = k_{CPi} \cdot P_i, k_{CPi} = k_{PCi}$ is increase of passionarity due to passionarians' activity. The coefficient k_{PCi} is the part of passionarians devoting themselves to culture and art activity;

7.2.

$$C_{Ci} = \left(1 - \chi\left(\text{sign }(\frac{dP_i}{dt})\right)\right)\chi(P_i - P_i^0)\chi(t - 500)\sum_{j\neq i} k_{CCji} \cdot C_j$$

is increase of passionarity taken from the culture subsystems of the other ethnoses when the passionarians of the ethnos $\mathcal{E}_i$ goes down but is still high enough. This is borrowing other ethnoses' culture at the decay phase ([2, p.201]);

7.3. $C_{Oi}^{(+)} = k_{COi}^{(+)} \cdot O_i, k_{COi}^{(+)} = k_{OCi}^1$ is support the culture by the State. It, apparently, is during all the time of existense of an ethnos, but it is not constant and, thus, can be described by variable coefficient $k_{COi}^{(+)}$;

7.4. $C_{Oi}^{(-)} = k_{COi}^{(-)} \cdot \tau_i O_i, \quad k_{COi}^{(-)} = k_{OCi}^2$, is decrease of passionarity, for some or other kinds of art are persecuted, if the State is of dictatorial or totalitarian type;

7.5. $C_{Li} = L_{Ci}$ is increase of passionarity, for the landscape subsystem influence upon the type of ethnos culture;

7.6. $C_{Mi} = \sum_{j=1}^{m} k_{CMij} \cdot C_i$ is decrease of culture passionarity used to educate the people of every ethnos;

8 Landscape.

The dynamics of the passionarity level of the landscape subsystem are described by the equation

$$\frac{dL_i}{dt} = L_{Pi} + L_{Mi} - L_{Oi} - L_{Ci}. \tag{8.1}$$

Here

8.1. $L_{Pi} = P_{Li}, \qquad L_{Mi} = M_{Li}$ is contribution to landscape transformation by the passionarian and harmonic people, respectively;

8.2. $L_{Oi} = k_{LOi} \cdot L_i$ is decrease of passionarity used for forming the organization of the ethnos;

8.3. $L_{Ci} = k_{LCi} \cdot L_i$ is decrease of passionarity used for forming the culture of the ethnos;

9 Initial conditions.

Initial conditions (1.1) can be assigned accordingly to the conditions the real ethnos may have.

Let us see the history of an ethnos from the very beginning of it. As a rule, an ethnos, being a unit of related ethnoses or a descendant of an ethnos, inherits a certain part of the culture (it is the third Gumilev parameter determining the ethnogenesis [2, p.456]). For example, the West-European superethnos had inherited the culture of Greek-Roman ethnos, the Russian superethnos had inherited the culture of Antique Russian and Gold Horde, etc. That means that we shall have to assume $C_{i0} \neq 0$. This condition provide nontrivial solution to system (2.1)–(8.1).

It is natural to consider other initial data (1.1) be nonzero.

10 The coefficients. Consideration of biological and social factors.

System of equations (2.1)–(8.1) contains a lot of coefficients of any kind. It is clear that it is necessary to assume them before the solving starts.

Some of the coefficients are of special significance. E.g., the coefficient k_{POi}, if it depends on natural-climatic and lanscape characteristics, is, as a matter of fact, the (first) landscape-geographical Gumilev parameter determining the ethnogenesis (see [2, p.456]). It is "the strict dependence upon the feeding landscape". On favourable conditions $k_{POi} > 0$ holds, and its growth means that passionarians' efforts, directed to making the State, are beneficial. Otherwise, their efforts are against making the State or, if $k_{POi} = 0$, are nothing to the State of the ethnos. In case of $k_{POi} \leq 0$, the part P_{Oi} is equal to 0 in equation (2.1).

As a rule, the coefficients depend on many variables that characterize the biogeocenosis and the ethnos as a part of it. According to the biosphere model stated in [7] the coefficients depend on such variable characteristics as forest and grass biomass, biomass of animal and vegetable food, population of the ethnos, humidity of the area, its pollution, humus biomass, capital per head of population, state of the country's industry and mining of natural mineral resources, and so like. Thus biosphere and, partly, social components determining ethnogenesis are considered in our model.

The complete consideration of sociosphere is impossible for the present, for mathematical model of sociogenesis is not worked out yet.

11 About sign of passionarity level.

It is possible that any of the function P_i, M_i, O_i, S_i, C_i can take negative values sometimes.

Suppose, in such a way, $P_i(t_1) < 0$. If also $k_{POi}(t_1) < 0$, then the item O_{Pi} contributes to increase the passionarity level of the organization. It can be interpreted as follows. As a matter of fact, the "negative" passionarians are conservative offering resistance to quick reforming the organization of the ethnos, if conditions are unfavourable. The "negative" subpassionarians have much the same point.

Negativeness of O_i means tendency to weakening the ethnos' organization, economics, civil responsibility, etc. Similary, negativenesses of T_i and C_i can be interpreted.

12 The condition of downfall of an ethnos.

With respect to §10 it is concluded that if there is a moment t_0 such that

$$P_i(t) < 0, \quad M_i(t) < 0, \quad O_i(t) < 0$$

holds for all $t \geq t_0$, then the ethnos $\mathcal{E}_i$ is considered to be ruined. The science and the culture can be inherited by other ethnos.

13 The time of ethnos' break-down.

Equations (2.1)–(8.1) contain items containing the expression $\chi(t-600)$. As a matter of fact, it restricts choise of admissible variants of ethnos development. In other words, we suppose a priori that there are certain conditions for the ethnos development during the first half of ethnos' life (600 years), and these factors are not valid after that. Thus, the number 600 seemed to be given from above, and the crisis appeared to be planned. For us, this circumstance is not likely to agree with. The right time for the crisis should rather come from the model itself than be determined beforehand. That means that the expression $\chi(t-600)$ should be replaced with $\chi(-\text{sign }(dP_i(t-h)/dt)))$, for example. The last expression means that the passionarians begin to go down. Or it can be replaced with the expression

$$\chi\left(\text{sign }(-\frac{dP_i}{dt}(t-h))\right)\chi\left(-\text{sign }(\frac{dM_i}{dt}(t-h))\right)$$

that means that the passionarians and the people go down together.

14 Passionarian intensity.

In [1, p.273], the notion of *passionarian intensity* was introduced. This is the value of passionarity per head of population. Let us define passionarian intensity of the ethnos $\mathcal{E}_i$ as

$$\Pi_i(t) = \frac{P_i(t) + S_i(t) + M_i(t)}{N_i(t)},$$

where N_i is the population of ethnos $\mathcal{E}_i$.

In [1, pp.339–340], a curve of passionarian intensity, which is generalized curve of 40 individual ethnogenesis curves of real superethnoses, is given (see Figure1). Thus, the accord between this curve and the experimental one is the correctness criterion for the ethnogenesis model.

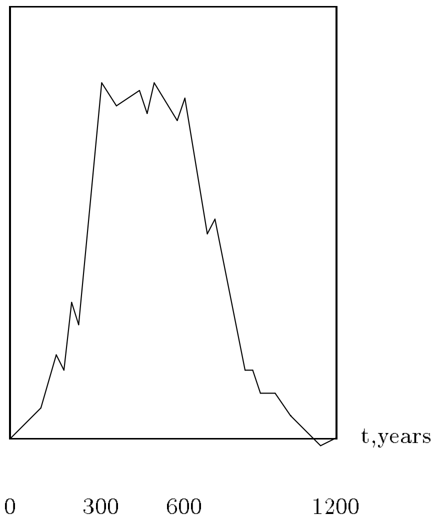

Figure 1.
The curve of passionarian intensity.

15 Computer modelling.

The computer modelling, of ethnogenesis, based on system of equations (2.1)–(8.1), (1.1) was made. A program in TURBO PASCAL language, which made it possible to change the coefficients, initial data, functions $\pi_i(t), \sigma_{ij}, \tau_i$, etc. and to picture the curves of passionarity level $P_i, S_i, M_i, O_i, T_i, C_i, L_i$ and the curve of the passionarity intension Π_i of interacting ethnoses, was made.

Ethnogenesis of two similar ethnoses of dictatorial type was modelled. The 1^{st} Ethnos was of high technology level, and the 2^{nd} was of high culture and art. The ethnoses were supposed to be at war periodically.

The curve of the 1^{st} Ethnos' passionarian intensity, we got (see Figure 2), turned out to be like to the curve that Gumilev gives, and the curve of the 2^{nd} Ethnos is absolutly another (see Figure 3). We see that the ethnos of high-level technology quickly destroyed the 2^{nd} Ethnos. The curves on Figures 2–13 (see below) correspond to description by Gumilev.

A list of all of the numeric values of the coefficients would take up a lot of room; as a rule, they are within $0.001 < k_{XYi} < 0.1$. The coefficient of passionarity inheritance is $k_{PPi}^{(+)} = 0.005$. The view of the curves is very sensitive to changing value of the coefficients (we can slightly vary them, though).

Self-extermination of the passionarians was described by the function $P_{Pi} = 0.004(1-exp(-0.03t))P_i$. The passionarian stimulus were $\pi_1(t) = 0.001t$ as $t \leq 5$, and 0 as $t > 5$; $\pi_(t) = 0.01$ as $t \leq 5$, and 0 as $t > 5$. The wars were as $\sin(\pi t/5) > 0.5$. The last, the population was supposed to grow linearly.

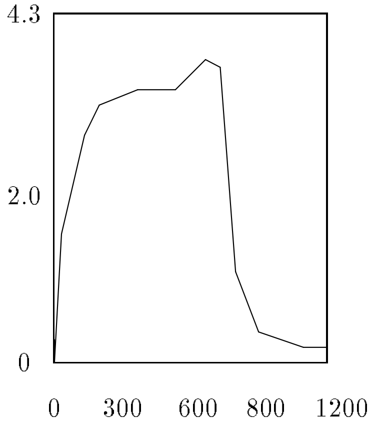

Figure 2.
The passionarian intension of the 1^{st} Ethnos

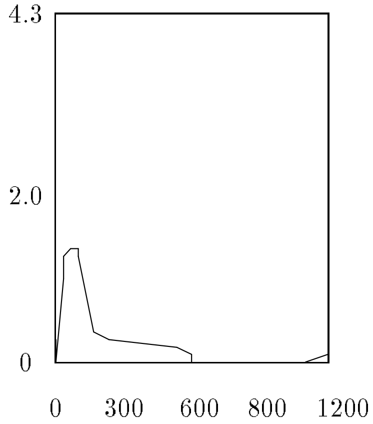

Figure 3.
The passionarian intension of the 2^{nd} Ethnos

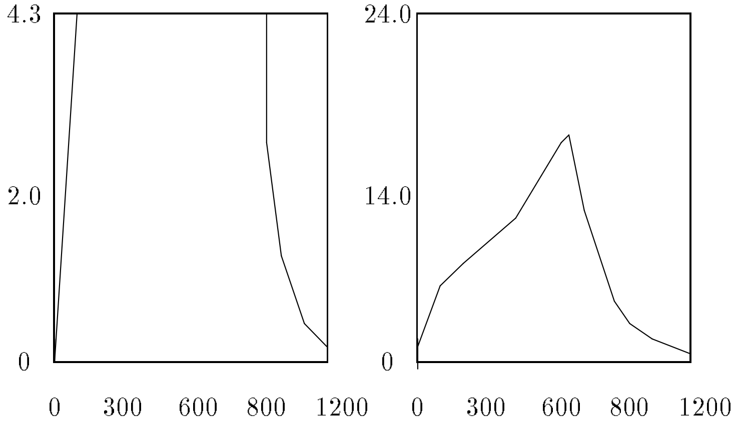

Figure 4.
The passionarians of the 1^{st} Ethnos

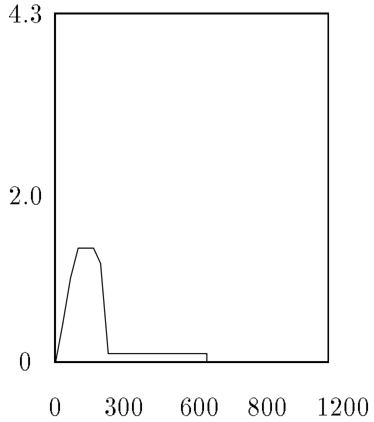

Figure 5.
The passionarians of the 2^{nd} Ethnos

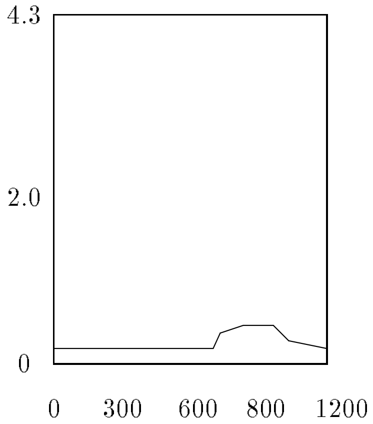

Figure 6.
The harmonic people of the 1^{st} Ethnos

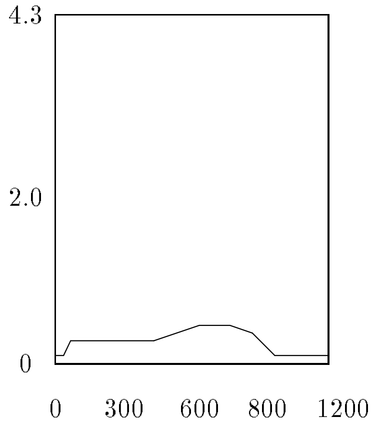

Figure 7.
The harmonic people of the 2^{nd} Ethnos

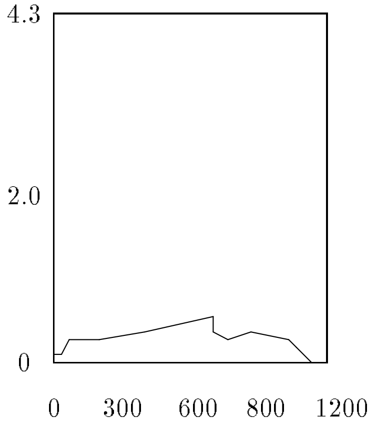

Figure 8.
The organization of the 1st Ethnos

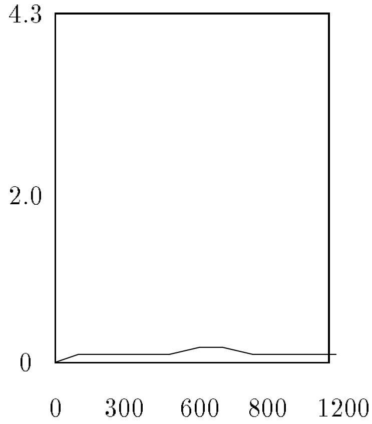

Figure 9.
The organization of the 2nd Ethnos

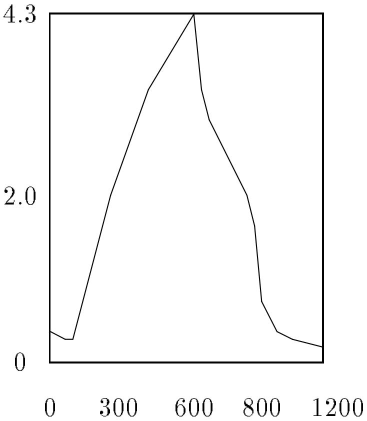

Figure 10.
The science and technology of the 1st Ethnos

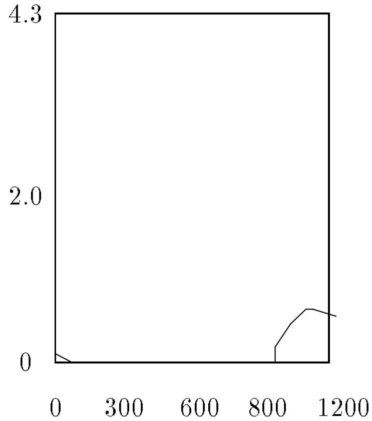

Figure 11.
The science and technology of the 2nd Ethnos

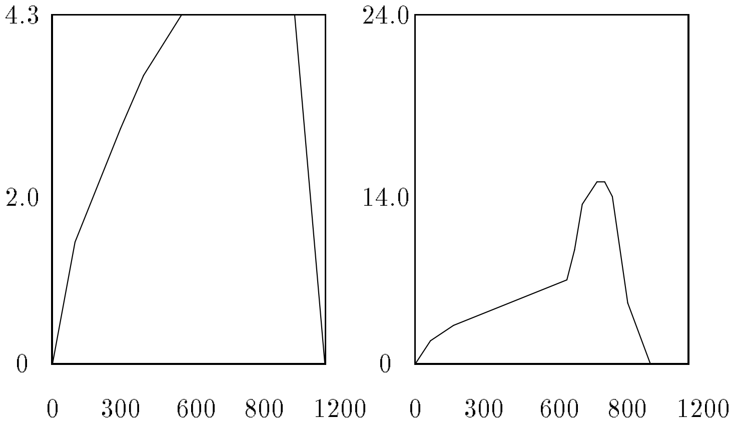

Figure 12.
The landscape of the 1st Ethnos

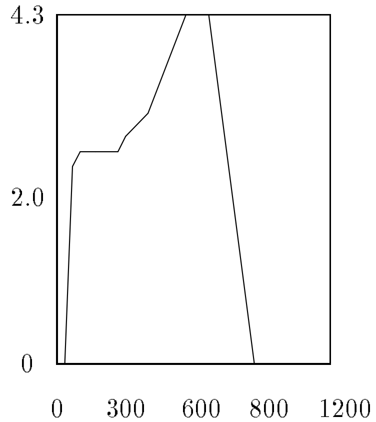

Figure 13.
The landscape of the 2nd Ethnos

What is the explanation for so narrow bounds for admissible values of coefficients and for the very values, which are so "exotic"? Apparently, the only anthropology principle, which states that the life on Earth may exist only if the main phisical constants are chosen carefully and only if they are as they are, can give the explanation, though rather philosophical than mathematical. This principle, applied to ethnogenesis, make us think that only the coefficients taken from within the bounds described above can correspond to a real ethnic system.

The computer expirement showed that different kinds of ethnogenesis are possible. The curve of Gumilev is an ideal curve only. Besides, the model proposed is "ethnic", and it does not consider social fartors, meanwhile Gumilev dealt with real historic data, which was of both ethnic and social kind.

Thus, it is necessary to consider social factors to model a society. That means that the functions σ_{ij}, τ_i must be determined by social system, and, in any case, should not be so primitive as above. A sociogenesis model, which is needed, proposed in [9, 10]. It is based on ideas of T. Parsons and E. Durkheim. Social processes are characterized by vector-function $\mathbf{\Sigma} = (\Sigma_1, ..., \Sigma_m)$, where $\Sigma_i = (\Sigma_i(1), ...\Sigma_i(4))$ is the society living in i-th area. The components $\Sigma_i(k)$, $(k = 1, ..., 4)$ are integration level of societal association (level of organic solidarity, by Durkheim), integration level of system of supporting institutial culture (ethnic) patterns (level of mechanical solidarity, by Durkheim), level of providing common purpose for a political system, and level of adaptation to the environment for the economic system. The dynamics of history for the i-th society is described by a system of four differential equations of 1^{st} order for the functions $\Sigma_i(k)(t)$ depending on t (time).

The complete model of a society can be built with unification the models [7], [8], [9] and [10].

References

[1] Gumilev L.N., 1993, *Ethnogenesis and Earth biosphere*, Mishel and C^o publ., Moscow.

[2] Gumilev L.N., 1992, *Antique Russia and Great Steep*, Kalashnikov, Komarov, and C^o publ., Moscow.

[3] Jaspers K., *Sense and Purpose of History (collection of articles)*, Politicheskaya literatura publ., Moscow.

[4] Danilevsky N.Ya., 1991, *Russia and West*, Kniga publ., Moscow.

[5] Spengler O., *Der Untergang des Alendlanders*, Mysl publ., Moscow.

[6] Toynbee A.J., 1991, *A Study of History*, Progress publ., Moscow.

[7] Krapivin V.Ya., Svirezhev Yu.M., Tarko A.M., 1982, *Mathematical modelling of global biosphere processes*, Nauka publ., Moscow.

[8] Guts A.K., 1994, Mathematical model of ethnogenesis, Paper N 1885 – B94, All-Russian institute of scientific and technology information, Moscow, Russia.

[9] Guts A.K., 1996, Mathematical model of sociogenesis, *The Second Siberian Congress in applied and industrial mathematics, Abstracts, Section of practice of mathematical modelling, Novosibirsk, Institute of mathematics, Russia,* p.7.

[10] Guts A.K., 1996, Mathematical model of sociogenesis, Paper N 3101 – B96, All-Russian institute of scientific and technology information, Moscow, Russia.

[11] Guts A.K., Lanin D.A., Nikitin S.V., 1996, Mathematical modelling of ethnogenetic processes, Paper N 3100 – B96, All-Russian institute of scientific and technology information, Moscow, Russia.