Simulation of Evolution Dynamics of Social System. Ethnic Solidarity Level
[Extended Abstract]

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Abstract. *In paper the hierarchical approach to construct the simulation model of complex social system is presented. We consider the society as a complex system. It has the hierarchical structure with following subsystem levels: biosphere, ethnosphere, sociosphere, psychosphere, anthroposphere. The next level is built on previous one by hierarchical rule. The main of presented research is a demonstration of creating the society model on ethnic solidarity level. This model describes the behavior of ethnic system as the separate part of general complex social system. The ethnic system includes a few ethnoses and provides their interactions. The interactions transmit by ethnic fields. The model is described by system of parabolic differential equations. The software TERRI is used for the forecast of arising the ethnic conflicts. Based on simulation result the researcher can compute the direction of ethnic field distribution and the most probable points of skirmish between ethnoses.*

1 Introduction

The Simulation is a new area in science, which appear on border of ages. The social scientists select the models of artificial society from a lot of simulation models. These models demonstrate the modern views about real society. To construct the mathematical and computer models is a process of theory formalization. The formalization technology allows analyzing the sociological theories. It helps to show the discrepancies and omissions of one or another the theory.

Thereby, in social science the actual problem is a search of possibility for making the system analysis of society evolution. For this problem decision, we propose to construct the complex model of social system on basis of the hierarchical approach. The socium may be represented by the hierarchical structure with following levels: biosphere, ethnosphere, sociosphere, psychosphere, anthroposphere. The study of these levels is based on building the computer models of artificial society. These models describe the social systems on each stage of its evolution. Thereby there is a possibility to make the forecast of society evolution by means of merging the models in a whole model.

2 Five Organization Levels of Social System

Social System is a way for organization of vital activity of individual group. The group is appearing as a result of social interaction of individuals on base of defined social roles. The system has social order and possesses self-preservation. The system parts are interconnected and interdependent units integrated in a whole.

We select five organization levels of social system: biosphere, ethnosphere, socioshere, psychosphere, and anthroposphere [2]. The hierarchical pyramid of organization levels is shown in figure 1. On each level the group behavior is described by defined rules directed on achievement of supplied aim. We will define the unique name for the people group, characterizing the organization level.

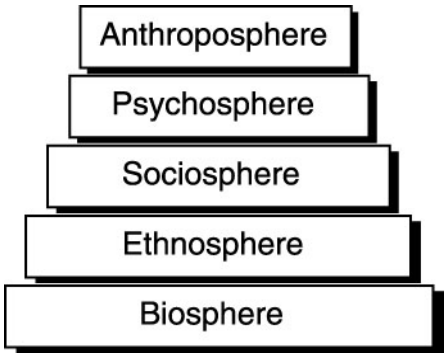

Fig. 1. Hierarchy of organization levels

On the first level, the group is presented as a subsystem of ecological system of Earth. We consider the biosphere of Earth from the standpoint of Vladimir I. Vernadskiy's theory [4]. The ecological system lives at the expense of solar energy and one participates in exchange of biomass with other subsystems of this level. The society is a collection of separated consumers that have not the influence each on other. They consume the alien biomass and give their biomass at a result of biological death. Such society is defined as a population.

On the second level, the group is an ethnos. Each ethnos member can consciously make alike actions. They have the some behavior stereotype generating by the landscape conditions. The group lives at the expense of biochemical energy initially given at the birth. The basis of this level is ethnos theory of historian Lev N. Gumilev [1].

The study of society pyramid is fixed on this level. The detailed consideration of other level is exceeded the bounds of the paper. However for modeling the social system on any level we can use the various theories describing the society. Each theory was arising on the respective stage of society evolution. These theories are rather complement than contradiction to each other. Modeling the social system on basis of each theory we will get the model of some level [3]. Further we will unite these models in a whole on basis of hierarchical principle. The united model will be most identical to real society.

3 Ethnic Solidarity Level

On the ethnosphere level the traditions play the special role in the society. The people get the behavior stereotypes from them. Thereby the general function of this level is the sample maintenance. The individuals strive for conservation of culture as a collection of history experience.

The *ethnos* is a people group, formed on basis of the original behavior stereotype. It exists as a energy system, opposing itself to other like groups. Thereby people are divided on own and alien man. The main ethnos attribute is a behavior stereotype. It is a complex of behavior standards of ethnos members. The collection of behavior stereotypes is defined by ethnic tradition differed the ethnos from biological population.

The *passio energy* is an excess of biochemical energy of living substance. It suppresses the self-preservation instinct of man and defines the ability to goal-directed ultratension. The ethnic field is formed by the passio energy. It provides the interaction of ethnos members and regulates the joint goal-directed activity of their. Each ethnos forms the unique field and each ethnos member responds to this field. The behavior stereotypes, landscape, and culture values of ethnos characterize the field influence.

The primary motive for arising the ethnic conflicts is a skirmish of two not solidary ethnoses. The skirmish is an effect of distribution of some ethnic field on the territory of another ethnos. There are the territories occupied by the people of different ethnic systems. Such territory is a border or buffer zone placed between two ethnoses. The ethnic conflicts mostly arise on these zones. Therefore the

actual problem is to discover the buffer zones and to forecast the ethnic conflicts. For this problem decision, we propose to use the methods of mathematical modelling. The model of level is created on the basis of Lev N. Gumilev's theory of ethnogenesis.

4 Mathematical Model of Ethnic Field

The model describes the behavior of ethnic system as the separate part of general complex social system. The ethnic system includes a few ethnoses and provides their interactions. The interactions transmit by ethnic fields. This field is distributed on the landscape as hot gas in the space. We constructed the model of ethnic field from this analogy. The model is described by system of parabolic differential equations.

Consider the interaction of k ethnoses in the field $G \subset R^2$ with boundary Γ. Let the passio energy of i ethnos (U_i) satisfies the energy conservation law in any given area. Define the passio energy density u_i by

$$U_i(t) = \iint\limits_G u_i(x, y, t)dxdy.$$

Then the change of function $u_i (i = 1, 2, \ldots, k)$ follows equation

$$\frac{\partial u_i}{\partial t} = \frac{\partial}{\partial x}\left(\frac{\partial \varphi_i}{\partial x}u_i + \varepsilon_i \frac{\partial u_i}{\partial x}\right) + \frac{\partial}{\partial y}\left(\frac{\partial \varphi_i}{\partial y}u_i + \varepsilon_i \frac{\partial u_i}{\partial y}\right) + \beta_i u_i - \sum_{j=1}^{k} \gamma_{ij} u_j u_i, \quad t > 0, \tag{1}$$

in any point $(x, y) \in G$. Here ε_i is a rate of passio energy distribution, φ_i is a transfer of the passio energy, β_i is a induction of the passio energy, γ_{ij} is a rate of passio energy loss under rivalry of ethnoses. Define the initial and edge conditions for the system of parabolic differential equations (1) by

$$\begin{array}{ll} u_i(x, y, 0) = u_i^0(x, y), & (x, y) \in G, \\ \frac{\partial u_i}{\partial n}(x, y, t) = 0, & (x, y) \in \Gamma. \end{array} \tag{2}$$

The system of parabolic differential equations (1) with the initial and edge conditions (2) is a mathematical model of ethnic field interactions.

Given model is a way for formalization of Lev N. Gumilev's theory. The model accentuates the energy and geographical aspects of theory and gives the clear formal description of internal processes.

5 Simulation Tools TERRI for Modeling the Ethnic Fields

The simulation tools TERRI is created for modeling of ethnosphere level. The tools realize the method for solving the system of parabolic differential equations that described the model of ethnosphere. The modeling result is demonstrated on the computer display as a dynamic map of ethnic fields.

The initial data for modeling are the number of ethnoses k, map of landscapes, rates of changing the passio energy (functions ε_i, φ_i, β_i, γ_{ij}), initial distribution of passio energy density u_i^0.

Consider the simulation result of ethnosphere on real example. The aim of simulation was to define the landscape dependence of division of territory between ethnoses. The dependence is discovered on real geographical features of Europe, North Africa, and Middle East. Examine the interaction of three ethnic systems: West European, East Slavonic, Asia Minor. Each ethnos was described by the set of features (the function in the system (1)).

After run the modeling software TERRI, the map of landscapes is appeared on the display. On this map the different landscapes are marked by various colors. The ethnos is born in some point on the map. So the ethnic field is got the initial pulse. According to dynamic rule (1) the field is distributing on the landscape. The ethnic field is marked by color area on the display. Each ethnos has own color: first ethnos – blue, second – red, third – green. Given picture is demonstrated the distribution of ethnoses on the landscape. The value of passio energy density is shown by the brightness of color. The three stages of ethnos dynamics is shown on figure 2.

Fig. 2. Distribution of ethnic fields

Initially the born ethnoses is developed on the isolation with each other. In time they come into collision observed by the ethnic field crossing. Under conflicts the passio energy of hostile ethnoses is loss. Since there are not solidary ethnoses then all they can not coexist on common territory. We can observe two way of conflict adjustment. Either the most powered ethnos forces out the feeble one or the equal-powered ethnoses separate the landscape. The buffer zone is formed between them.

The software TERRI allows doing a lot of tests with model. We fixed the part of initial parameters but were changed other parameters in various tests. We were getting the various pictures of ethnic dynamics. For analyzing the model behavior we was collecting the data of ethnos field distribution. The statistical analysis is demonstrated the dependence of ethnic field distribution on the landscapes.

The analysis of computer simulation results allows doing the following conclusions:

- the distribution of territories between ethnoses really depends on landscape;
- the obtained statistical data demonstrates the correlation of settling the ethnos on landscapes;
- the size of buffer zone is depended on the hostility of neighbor ethnoses.

6 Conclusion

We constructed the model of complex social system on ethnosphere. The model describes the second organization level of hierarchical pyramid of society. The ethnic level is joined with biosphere one by landscape.

On results of presented research we can make up the following conclusions:

- this model is the tools for investigation in global development society area. Based on simulation result the researcher will have got the numerical evaluation of historical hypothesis on ethnosphere evolution;
- the software TERRI is used for the forecast of arising the ethnic conflicts. In that case, it is necessary to keep track of the passio energy pulse. Then we can compute the direction of ethnic field distribution and the most probable points of skirmish between ethnoses;
- one of the ways for ethnic conflict prevention is to fix the territory for certain ethnos. The landscape features characterized for this ethnos define these territories. So the separation of influence area of ethnos on territories is realized.

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