Committee 4
Treatment of Non-linear Systems in
Physics and Economics

DRAFT--Sept. 12, 1997
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SOME FLUCTUATION REGULARITIES OF SOCIAL DEVELOPMENT

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The Twenty-first International Conference on the Unity of the Sciences
Washington, D.C. November 24-30, 1997

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Many phenomena in nature and society, associety with a shift in space of large volumes of particals of different origin, bonded with each other, shoud demonstrate certain general dynamic properties by virtue of the structural similarity of such systems and universal character of fundamental laws of motion.

Hydrodynamics has accumulated much experience in the investigation of similar collective motions. One of the important regularities, established by this science, is the dependence of the development of such system on their stability. A significant effect of instability is noted in the development of social systems. In addition, there are few publications, in wich this problem is examined on a single methodical basis.

The present paper is such an attempt to investigate certain quantitative regularities between parameters of development of collective physical, social systems and parameters of their dynamic stability.

Let us write for this purpose the equation of motion for a small volume of space, in wiche is present a quite large set of elementary particals with density ρ. Assuming that a certain set of natural forces F acts on these particles, we will express the change in the instantaneouse velocity U of the elementary volume of such a "medium" withe the use of the Newton law

$$dU/dt = F \qquad (1)$$

This equation give littel information as applied to a typical state of "chaotic" motion of the examined medium. Instantaneous trajectories of movement of particles are not only practically unpredictable, but are also qualitatively not rich in content. Here only the picture of development of the system on average shoud be examined, when the process can be presented as a certain sequence in relation to constant state. Such an averaging procedure has been well developed in hydrodynamics and has the name of Reynolds averaging [1].

$$dU/dt - F = \Phi. \qquad (2)$$

All values in Eq. (2) differ from analogous values in Eq (1) in that they are averaged with respect to a certain representative time interval T.

According to Eq. (2) acceleration of motion of the separated system of particles on the average is not equel to the sum of all sets of forces, applied to the system. There is always a certain imbalace, quantitatively expressed by value Φ

$\Phi = d(\overline{u_i v_j})/dx_i$,

vhere u_i ,v_j - components of velocity fluctuation.

This kinematic characteristic of fluctuation, being a quantitative measure of deviations from a dynamic equilibrium or of values, derived from the characteristic, e.g. the rate of energy dissipation ($\varepsilon = \Phi u$), and also the characteristic time and length scale (t, l), which may be assumed to estimate of the unstable development of collective systems of different nature.

In 1941 A.N. Kolmogorov established one of the fluctations law of such systems. According to this law between the energy of vibrations of various part of medium E and their length scale l exists the relation:

$$E = u^2 = C(\varepsilon l)^{2/3}, \qquad (3)$$

where C is the Kolmogorov constant.

Investigation, carried out rescently [2-4], made it possible to refine the law. Quantity C is a function of the degree of local instability of the flow. Using for evaluation of the degree of stability the flutuation parameters of motion, according to [3,4], we write:

$$C = C_0 (1- l/L)^2 \qquad (4)$$

where L is the scale of the largest stable structure, determined by dynamic characteristics of the process as a whole; C_0 is a constant.

An estimate of the lifetime of unstable structure as a function of their length scale l can be obtained, on the basis of Eqs. (3) and (4):

$$t = l^{2/3} /(1- l/L)(\varepsilon)^{1/3} \qquad (5)$$

Accoding to Eq. (5) the time of existence of a collective system of particles initially increases with an increase in its length scale to the 2/3 power, and them asymptotically aims for infinity with approach to dimensions of the stable structure L.

It was also observed [3] that under certain dynamic conditios, in which length L aims for infinity, discrete structure of identical size are formed in collective systems

$$l = \text{constant}. \qquad (6)$$

On the basis of the described theoreticacal model of fluctuating processes it was possible to systematize some statistical data of social nature.

One of the purest social experiments on state development was achieved on the American continent in the period of its conquest and bringing new land. The examinations of the history of American states in purely physical variables - time of existence of state, its maximum length scale - made it possible to observe a certain regularity. The dependence of the lifetime of states on their length is seen in Fig. 1 [5].

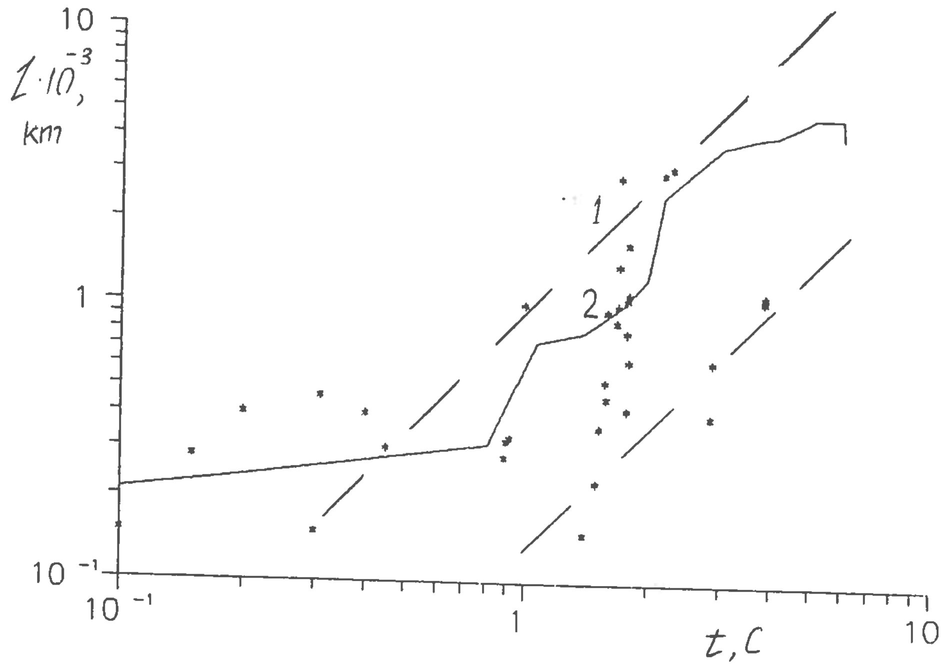

Fig. 1. Dependence of lenght scale of American states on their times of existence (points). Comparison with Kolmogorov dissipative law (1) and trajectory of Russian state development in the period 15-20th centuries (2).

The line (1), corresponding to the law of unlimited ($L>>l$) expansion in space of collective systems (5), is drawn next to results of social experiment, carried out by nature. The solid line (2) on this graph shows the dynamics of development of Russian state from 15th century to the present day. In our opinion, physical laws (5) and (6) describe accurately two general stages of processe: Eq. 6 - stady state (during 1st century) and Eq.5 - expansion (2 - 5th century).

The rate of dissipation of energy in processes of social development can be estimated with Eq. 5. On the American continent, it was equal to the order

$$\varepsilon = 10^{-17} (m^2/c^3).$$

We can see also in Fig. 1 the characteristic size of social structure in time and space:

t = 90-100; 160-180; 270-300; 350-380; 550-600 years;

l = 120-150; 280-320; 400-450; 900-1000; 3700-47 00 km. (7)

The estimation on this basis the diffusion coefficient give us:

$D = (l^2/t) = 200\text{-} 25000$ (km^2/ year).

The fluctuation character of social development appears not only in time, but also in the character of energy distribution in space. The energy of society, measured like heat production and electrical power production, shows in Fig. 2.

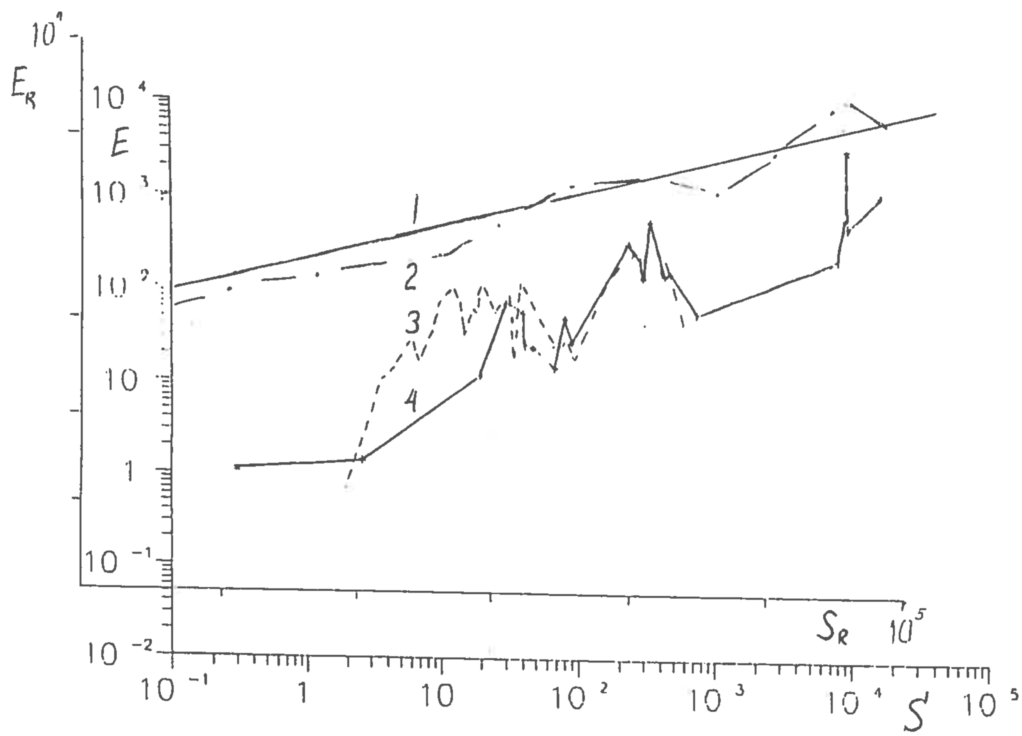

Fig. 2. Distribution of society energy generation (in billion kwt\hr) on the eath area (in thousand km^2); 1- Eq. (3), 2 - heat production [6], 3 - electrical power production in Russian regions, 4 - electrical power production in the world states.

The energy of any, quit large set of people initialy slowly increases with eath area S to 1/3 power, accoding to Eq. (3) (curve 1 in Fig. 2), and then rapidly decreases upon approach to a certain critical limit, determined by equations (7) $S = l^2$.

Data presented in this paper are only a small part of results of the investigation of regularities of fluctuation development of collective systems of social nature. They are assurance of effectiveness of examination of dynamic of social systems from the position of their unstable development.

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