Information indicators of soil texture for holistic numerical assessment of soil evolution

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Abstract. The concept of probabilistic determinism is proposed to overcome a problem of significant soil variability which complicates finding of adequate models of soil development. Probabilistic and information indicators as characteristics of evolution of complex systems expand borders of use of soil texture results, allowing correct comparison with other natural and artificial systems on the earth and other planets. Probability distributions, statistical entropy and information divergence of granulometric fractions’ contents are investigated. It is suggested to use these functions as statistical standards of granulometric composition for territory. Regularities of change of probability distribution functions and scale-independent information characteristics allowed receiving holistic numerical assessment of influence of processes of sedimentation, weathering and soil development also geological and contemporary deflation and anthropogenic impacts on probability structure of granulometric fractions contents.

1. Introduction
The development of quantitative criteria for numerical assessment of soil evolution leads to the need for modern philosophical reflection and a fundamental approach to determining the nature of mathematical models of soil evolution, on the basis of which the proposed estimates are determined. At the heart of the analysis and solution of an extensive class of research problems are ideas about determinism, which are related to the development of basic models of the world's structure and its evolution [1]. Indeed, the fundamental basic of soil science is deterministic Dokuchayev's doctrine of soil dependence on soil formation factors.

Strictly deterministic laws give exact predictions only where it is possible abstracting from the complex nature of interaction between physical bodies and their parts, to distract from randomness's, to simplify reality. For this reason, now the determinism is defined in two forms: Laplace, or mechanistic, determinism which is a cornerstone of universal laws of classical physics and the probabilistic determinism which is guided by statistical laws. A frequency, or statistical interpretation of probability, dominating now, emphasizes the objective maintenance of a concept of probability because considers it as quantitative characteristic of stability of frequency of mass accidental events. Thus, strict and probabilistic determination are integrally combined in the modern concept of determinism. As a result of it a necessity and randomness act as the interconnected and supplementing aspects in a new picture of the world [2].

It is time to develop this concept in soil science as well, while preserving the Dokuchayev's deterministic concept as leading. This combined approach to quantification in soil science is more in
line with the modern idea of the polygenesis of soil profiles. It allows quantifying soil properties in terms of perceptions of soil as an open complex system using information characteristics. Methods of setting and expressing of probability distribution functions (pdf) of values of different system's properties in the study of objects and processes, including soil, play a major role in this regard [3]. Information characteristics of physical systems which can be defined from pdf of system's properties, are: information entropy, information divergence and other. They are characteristics of physical values, states and change of states of systems, which can be useful as measurement of systems complexity and other features of systems, for assessment of their evolution and interaction with other systems [4].

2. Methodology
Researches in soil genesis, paleopedology and quantitative modelling of development of soils face significant variability of soil properties which takes place even in almost homogeneous conditions. It complicates consideration of soil evolution and finding of its adequate mathematical models and parameters. The concept of probabilistic determinism according to modern philosophy of science allows considering variability of properties of soils as their inherent property. Probabilistic distributions of soil properties are structural characteristics of statistical systems, which show how separate elements of system correspond with the whole system, so they characterize holistic properties which have basic nature.

2.1. Changes in Probability Distributions of Soil Properties Under Natural Processes and Anthropogenic Impact
Statistical distributions of soil properties under anthropogenic and natural processes have long been discussed in Russian literature. Vauclin reasoned that the normal distribution is inherent to static soil properties, while the lognormal distribution is typical for dynamic properties. Kozlovsky [5] noted that the spatial differentiation of the soil evolution processes gives rise to the asymmetry of empirical statistical distributions for dynamic parameters of soil, specifically, causing the normal distribution to be lognormal. The authors note that the change in the dispersion parameter with time can serve as a reliable indicator of soil change.

The statistical analysis of a great body of soil data allowed the development of a model for the variations of the shape of statistical distribution (figure 1). Consider soil process Y which is caused by environmental conditions which are either natural or anthropogenic and results in the quantitative increase of soil property X, whose initial distribution had a small dispersion (figure 1a).

**Figure 1.** Stages of changes in the statistical distribution of soil properties; *(inf)* is the least possible limit of the variability of a property in a specific soil; *(sup)* is the highest possible limit of the variability of a property in a specific soil; *(M)* is the mean value of a property; for *(a–e)* explanations in text.
Over time, the notable increase in dispersion and right asymmetry for variable X(X1,X2,...,Xn) in space (figure 1b) indicate that several values which substantially exceed the mode correspond to the areas that are susceptible to the given environmental change. Simultaneously, most of variable X retain moderate values; hence the corresponding areas are tolerant to the environmental influence. Thus, the right asymmetry of statistical distribution suggests a weak dispersion or the beginning stages of the process Y on the area. Under constant environmental conditions responsible for the development of the process Y, the asymmetry of statistical distribution of X decreases, and the distribution becomes more symmetrical with higher dispersion (figure 1c).

A large decrease in the distribution tail can result in the split of the distribution curve (dotted line, figure 1c), which indicates heterogenisation. In other cases, further development of the process Y can result in the left asymmetry of statistical distribution of parameter X (figure 1d), which suggests the approaching of the limiting spatial distribution of the process. Here, the upper boundary of variability reaches its limit, which is determined by the nature of soil properties, and most of values are grouped around the mode in the upper part of the variation interval.

Further development of the process results in decreasing scattering of values, and the shape of distribution becomes more symmetrical (figure 1e), which suggests the completion of the process on the area and its homogenisation in relation to a given property. Considering the process resulting in the quantitative decrease of a property, one can observe the reverse sequence of changes in statistical distribution (figure 1e–1a). Certain ratios of conditions, factors and internal properties of soil systems, the existence of straight lines and feedback create quasi-equilibrium change. Simultaneously, most of variable X retain moderate values; hence, the states which define the real limits of variation of soil properties (min – max) which do not coincide with their potential limits (inf – sup). Stages of transformations of soil probability density functions during soil evolution are shown in figure 1 in the case where the potential limits of variation of a soil property are close to their real limits.

In the case where the potential limits of variation are far from the real limits, the stages of change of the shape of statistical distribution can go on several paths (figure 2 a–i) according to the recurrence of environmental change.

**Figure 2.** Theoretical stages of changes in the statistical distribution of soil properties; inf is the least possible limit of the variability of a property in a specific soil; sup is the highest possible limit of the variability of a property in a specific soil; M is the mean value of the property states.
The actual statistical distributions of soil properties can correspond to any of the patterns presented in figure 1 or an intermediate one, depending on the development of the processes responsible for these properties and on the soil-forming factors governing these processes. The multiplicity of statistical distributions of soil properties possesses some regular trends, which can be used for the diagnostics of the development of natural and anthropogenic processes.

The analysis of the shape of statistical distribution of soil properties is promising for characterisation and evaluation of soil transformation and evolution because the shape of distribution reflects the degree of manifestation of processes responsible for these properties and can serve as an indicator of the stages of their development and spatial distribution of soil properties in an area.

2.2. Objects and methods.

“Basic diagnostic parameters” of soil processes (texture fractions contents, humus content, pH, etc.) are most important properties for modelling soil development [5]. Soils on 70-80% consist of the mineral particles formed from geological rocks. The granulometric structure is one of the lithogenic properties of soils. It is considered to be one of the most conservative properties of soils with rather long time of native change - \( 10^2-10^4 \) years. The genetic aspect of development of modern soils is estimated by distinction of the contents of granulometric fractions in soil horizons which vary in space very much. The reason of this changeability is non stationary processes of transport and sedimentation during humid phases on territories and moving of particles during a wind erosion (geological and anthropogenous) during the droughty periods. Moreover, the regional transport of particles by air takes place in Kazakhstan and Western Siberia where our investigations were conducted. In result there was a significant variability, and the texture characteristics can differ very essentially in different but similar soil profiles.

Parent materials of researched soils represent well sorted quaternary air sediments on ancient lake alluvial deposits with dominance of small sand. The structure of granulometric composition of modern soils (Kastanozems) was generated basically under rock weathering, soil formation, and transference of particles by a wind and their accumulation during the droughty deflationary periods. Such genesis of the territory is a reason of great variability of soils on granulometric composition from loose sand to sandy clay loam. The ratio of granulometric fractions is similar in all investigated soil varieties (figure 3). Simultaneously, the contents of all fractions essentially and unequally varies within these varieties. Large fractions vary in the greater degree that is related to alluvial genesis of parent materials and the deflationary periods in development of these soils [6, 7]. The combination of predefined and uncertainty of spatial variability of granulometric fraction contents needs applying the complex approach which is mentioned above.

2.2.1. Initial data and data base. We have used materials of four soil surveys (scale 1:25000) at territory of 16 thousand km\(^2\) situated in the south of Western Siberia in Kulunda steppe: survey of soil deflation; soil survey; and surveys on irrigated fields [8]. These soil investigations were conducted by standard methodic [9].

The information about 4 thousand full soil profiles of Kastanozems luvic [10] was input to database. The information corresponds to soil properties, namely: depth of horizons, pH, and the contents of humus, the contents of fractions of texture, the contents of salts, and others in separate genetic horizons or layers of soils. Data have been grouped according to year, usage and texture varieties by Kachinsky [11] before doing statistical analysis. Such soil varieties corresponded to Soil classification of that time [12]. (The analogical approach was in soil taxonomy of USA [13] where traditionally join in the classification scheme of soil series - groups of the soils differing only in particle size distribution.) Peculiarity of our grouping was that we divided variety of loamy sand variety (clay content 10-20%) to light loamy sand (10-15%) and heavy loamy sand (15-20%) varieties. This step was caused by great dependence of tendency to deflation on clay content within loamy sand variety. It is important because loamy sand Kastanozems are most widespread soils in the investigated
territory. They take place about on 60% (30% and 30%) of all Kastanozems, and they were exposed to strong deflation at 60th years of previous century [6, 7].

Then after data grouping, received data samples were analyzed by methods of mathematical statistics, probabilistic and information assessment. Correctness of such grouping has been confirmed by unimodality of probabilistic distributions of soil properties, which were received during our statistical investigation.

![Figure 3](image-url)

**Figure 3.** Averages of granulometric fractions * contents in top horizon of Kastanozems within varieties (by Kachinsky [11]) in south of Western Siberia.

*Granulometric fractions were defined by standard in Russia methodic by Kachinsky [11]: clay - < 0.001 mm; light silt - 0.001—0.005mm; medium silt - 0.005—0.01; heavy silt - 0.01—0.05: fine sand - 0.05—0.25; coarse (+ medium) sand - 0.25—1.0 mm.

2.2.2. **Statistical and mathematical procedures.** Quantitative modelling of development of soil, as statistical system, leads to necessity of more exact mathematical description of probability distribution functions of properties and their assessment. For statistical identification of probability distributions we used principle and software, when many hypotheses about coincidence were checked with big set of theoretical functions. In each case we have chosen the only function with its parameters, which is the best approximation coordinated with set of parametric and nonparametric criteria [14, 15]. Usage of big data samples (n = 50…600) gives us confidence that the form of probabilistic distribution received by this statistical procedure is close to its real form.

Creation of a model of probabilistic distribution in practice happens by identification of the closest known probabilistic distributions. Identification of distribution consists of a number of stages:

1) several statistical distributions, the most suitable for the studied data are chosen from the list of about thirty known function;
2) according to data sample assessment of parameters of the chosen distributions is made by the method of maximum likelihoods;
3) for each distribution the hypothesis of the consent of a sampling and theoretical distribution is checked by the chosen criteria. We used a row of parametric and nonparametric criteria;
4) according to the set of indexes of several criteria, the theoretical statistical distribution of the closest approximating to sampling factual distribution is chosen.

As a result of application of this statistical procedure to data samples of values of soil properties in soil horizons we received the bank data about probability distribution functions of soil properties in soil horizons with information like in table 1.

These probability distributions permit clear visualisation of regularities of soil's property quantitative variability and comparison of their functions in different soil horizons (layers) or in different soils in the same horizon, or soils in different states and other. Studying of pdf brought the idea that there is a need to have some convoluted numerical characteristic of soil variability and development, that should be calculated from probability distribution functions of its properties. Statistical entropy is such an index, which is calculated from pdf and can serve as a numerical system characteristic [4]. We tested this idea on data of humus content and texture fraction content and other properties in soil profile [16].

The value of statistical entropy, using probabilistic distribution may be calculated by the formula (1), where \( f(x) \)-probability distribution functions of continuous random value \( x \), \( A \) is the set where \( x \) is defined:

\[
h = -\int_A f(x) \log f(x) dx
\]  

Values of entropy characterize a measure of uncertainty of the micro events consisting in distinctions of soil properties. If \( h \) is not big, it means that values of the researched variable are levelled, less chaotic, and if \( h \) is great - it testifies the greater chaos. So entropy can be interpreted as numerical indicator for processes of homogenization and heterogenization in soils.

A quantitative comparison of the pdf of soil properties in different horizons provides a holistic estimation of changes in their variability. We had proposed to use mathematical value of informational divergence for convoluted holistic estimation of changes of pdf of soil properties [17, 18]. To estimate how the pdf \( W_1 \) and \( W_2 \) of soil properties differ in different horizons, or at different moments in time or in different soil states we used the value of divergence \( d \):

\[
d = \int_{-\infty}^{\infty} (W_1(x) - W_2(x)) \ln \left( \frac{W_1(x)}{W_2(x)} \right) dx
\]  

An information divergence \( d \) is defined by first axiom of distance, that is \( d(p, q) \geq 0 \) with equality if \( p=q \). This divergence is symmetrical and assesses difference of probability density functions in whole of their interval of variation. Symmetry of divergence means that there are no preferences between different states of soil. As a measure of dissimilarity, divergence should satisfy some conditions. The most important property of such values is the scale-invariance [4, 19].

3. Results and discussion
We received the data base about types and parameters of probability distributions of texture fractions’ contents in genetic horizons of Kastanozems at the big territory of western part of Kulunda steppe and other territories by performing statistical and mathematical procedures mentioned above. We consider these probability functions as probability and statistical standards of texture fractions contents in these territories. Example of such information for loamy sandy chestnut soil is provided in table 1.

Analysis of results shows that types of probability distributions of texture fractions contents do not correspond to normal distribution as a rule. It is usually Su-Johnson distribution for clay and silt contents, distribution of the minimal value for fine sand, and - Weibull’s for large sand. The common features of obtained functions are the asymmetry and narrow central part (figure 4). According to our model of change of form of probability distribution functions asymmetry of distributions testifies orientation of the tendency of the current or finished process, see item Methodology and [14].

In our opinion, generally, narrow centers (“nucleus” of classes) are a natural feature of probability distribution functions of properties for natural systems under evolution processes. Namely, in soils,
they are attractors of properties, representing asymptotically steady sets of soil. Existence of such steady sets lowers the entropy.

Table 1. Types, parameters, and statistical entropy of probability distribution functions of contents of granulometric fractions in loamy sand Kastanozems (n=625).

| Fraction     | Horizon | Type of Function          | Parameters $^a$: $\theta_0; \theta_1; \theta_2; \theta_3$ | p-value $^c$ | Statistical entropy $^d$ |
|--------------|---------|---------------------------|----------------------------------------------------------|-----------|--------------------------|
| Clay         | A       | Su-Johnson’s              | -0.43; 1.78; 2.21; 7.27                                   | 0.9       | 1.8                      |
|              | B1      | “-“                       | -4.39; 1.29; 10.99; 0.29                                   | 0.6       | 2.5                      |
|              | B2      | “-“                       | -0.64; 1.05; 2.46; 10.2                                   | 0.4       | 2.6                      |
|              | BC      | “-“                       | -0.45; 1.71; 3.46; 8.83                                   | 0.3       | 2.3                      |
|              | C       | Ln-normal                 | 2.25; 0.24                                               | 0.6       | 2.2                      |
|              | A       | Su-Johnson’s              | 0.22; 1.76; 2.2; 6.16                                     | 0.9       | 1.8                      |
|              | B1      | Exponential               | 5.81; 1.58; 2.23                                         | 0.7       | 1.9                      |
|              | B2      | Su-Johnson’s              | -0.9; 1.07; 1.17; 3.84                                   | 0.3       | 2.0                      |
|              | BC      | Su-Johnson’s              | -1.0; 1.36; 1.44; 2.57                                   | 0.7       | 1.9                      |
|              | C       | Ln-normal                 | 1.13; 0.49                                               | 0.6       | 1.8                      |
|              | A       | Su-Johnson’s              | -0.77; 1.62; 1.65; 2.69                                   | 0.7       | 1.7                      |
|              | B1      | “-“                       | -1.07; 1.72; 1.72; 2.31                                   | 0.9       | 1.7                      |
|              | B2      | “-“                       | -0.97; 1.58; 1.47; 1.72                                   | 0.5       | 1.6                      |
|              | BC      | D. of maximal value       | 0.81; 1.31                                               | 0.6       | 1.3                      |
|              | C       | Su-Johnson’s              | -3.61; 1.88; 0.42; -0.27                                  | 0.7       | 1.2                      |
|              | A       | “-“                       | -0.31; 1.27; 2.96; 8.20                                   | 0.6       | 2.5                      |
|              | B1      | “-“                       | -0.63; 1.62; 3.89; 7.71                                   | 0.8       | 2.5                      |
|              | B2      | “-“                       | -0.89; 1.16; 2.45; 5.93                                   | 0.2       | 2.6                      |
|              | BC      | D. of maximal value       | 1.94; 4.54                                               | 0.6       | 2.2                      |
|              | C       | Su-Johnson’s              | -1.67; 1.24; 1.18; 2.08                                   | 0.8       | 2.2                      |
|              | A       | D. of minimal value       | 51.15; 8.33                                              | 0.2       | 3.7                      |
|              | B1      | “-“                       | 49.30; 7.96                                              | 0.2       | 3.6                      |
|              | B2      | Logistic                  | 50.74; 4.61                                              | 0.7       | 2.9                      |
|              | BC      | Normal                    | 58.21; 7.51                                              | 0.5       | 3.4                      |
|              | C       | Exponential               | 64.05; 6.62; 1.02                                        | 0.2       | 3.5                      |
|              | A       | Su-Johnson’s              | -7.69; 3.14; 4.27; 1.68                                   | 0.4       | 3.5                      |
|              | B1      | Weibull’s                 | 2.47; 19.43; 5.89                                        | 0.5       | 3.4                      |
|              | B2      | Logistic                  | 19.08; 4.01                                              | 0.9       | 2.8                      |
|              | BC      | Weibull’s                 | 1.93; 17.7; 4.0                                         | 0.4       | 3.5                      |
|              | C       | D. of maximal value       | 14.05; 6.99                                              | 0.6       | 3.5                      |

$^a$see formulas for probability distribution functions in [14]

$^b$Parameters $\theta_0; \theta_1; \theta_2; \theta_3$ are parameters of scale, shift, and two parameters of form of functions of probability distribution. For different types of functions the order of parameters can differ [14, 15].

$^c$the average value for reached probability for statistics of different statistical criteria. They are greater significantly than standard level of probability 0.05.

$^d$values of statistical entropy were calculated by equation 1.
Figure 4. Probability distribution functions of granulometric fractions’ contents in horizons of loamy sandy chestnut soil, in lines: red - A, blue - B1, rose - B2, black BC, and green -C.

But as normal (Gauss’s) distribution, possesses maximal entropy in defined interval of variation therefore it is not peculiar to the natural soil systems after evolutionary way of development which leads to emergence of steady state objects.

Interpretation of entropy parameter in natural sciences was often contacted with an extreme principle - raising value of entropy characterizes change of a state of systems of various nature during their natural evolution. The corresponding principle of development has received the name of a principle of maximum entropy. For closed thermodynamic systems the entropy of their properties grows or it is constant (the second law of thermodynamics). Expansion of this principle to the Universe and processes within it led to representation about «entropy arrow» [20]. But there are many results, which confirmed more complicated behaviour of entropy in open systems [21].

Change of pdf of clay content in soil profile is such case. Analysis of statistical entropy results shows that in horizon B1 it is much higher than in horizon A (figure 5). So illuvial process considerably raises statistical entropy of granulometric structure of soil profile. Increasing of natural variability in horizon B, with illuvial soil forming process, apparently, is caused by heterogeneity of infiltration of moisture.

Various variants of change of probability distribution functions and information characteristics of the contents of granulometric fractions in soil profile are possible in connection with processes of sedimentation, rock breaking and soil formation, as well as geological and contemporary deflation. First variant is a strong change of pdf, evaluated by information divergence, like differences of sand and silt fractions contents in horizons A and B1 comparing with horizon C (figure 4, table 2). Despite this the entropy differs not very much. So changes of texture in processes of sedimentation and rock breaking took place in all loci rather homogeneously.

Probability distributions of the contents of heavy silt and coarse sand in horizon C are shifted to the left in comparison with horizons A and B1. Hence, the contents of these fractions in parent rock in all
samples are much less, than in the top horizons of soil that also testifies that this material is introduced to the given territory probably from neighboring geomorphological area which is characterized by coarser texture of soils. Shift of pdf of light and medium silt in the top of horizons could be a result of rock breaking and receiving such particles by air wind streams from other territories located to the southwest in central and west Kazakhstan.

Figure 5. The entropy of texture fractions’ content in chestnut loamy sand soil.

As it has been shown above (figure 3), fine sand fraction prevails in texture of soils and parent rock, but its contents in soil decreases concerning parent rock probably as consequence of growth of content of coarse sand (figure 4). Comparison of probabilistic distributions of the contents of sandy fractions in horizons A and B1 of investigated soil shows that in the top part of profile modern deflationary processes render influence on them: for fine sand it is reflected by small shift of pdf, but keep the type of function. Probability distribution of coarse sand content in B1 horizon changes its type concerning pdf in A horizon (table 1).

The content of clay is characterized by more close values in the soil profile, thus its intervals of variation in horizons A, B and C are considerably crossed, and information divergence is not so big. But soil development in steppes leads to a partition of a profile owing to formation of illuvial horizon which is more condensed, distinguished on structure. It is reflected by distinction of pdf of the clay contents in horizons A and B1 which are assessed by a big value of relative change of entropy and values of information divergence (table 2).

The strong deflation in twentieth century has led to a reorganization of pdf of fractions of sand and silt in upper horizon, without essential shifts of pdf of clay. Statistical entropy of all fractions has increased on less than 6 %. As a result of a long arable usage there was a small growth shift of pdf of the contents of small fractions as consequence of the involvement of fine particles from top part of illuvial horizon into ploughed layer. Statistical entropy of these fractions has decreased on 12 %, and entropy of sand fraction - on 6 %. So influence of arable usage and contemporary deflation on probability structure of granulometric fraction composition is not very strong.

Nevertheless, irrigation influence analysis by lower-mineralized water at plots of the same soil in investigated territory, has shown that this anthropogenic impact has caused essential shift of pdf of the contents of fine sand and clay, thus their statistical entropy has decreased on 50-70 % [7]. Hence, granulometric composition shows stability under deflation and a long usage in arable land, but it is not stable at irrigation. In our opinion essential decreasing of statistical entropy of content of
granulometric fractions could be one of the reasons of negative process of cementation of surface of irrigated plots, that has worsened quality of soils and has reduced efficiency of irrigation.

Table 2. Relative increment of the statistical entropy and information divergence of soil texture fractions’ contents in loamy sandy chestnut soil.

| Texture fraction | Indicator | Increment of statistical entropy (%) | Information divergence* |
|------------------|----------|--------------------------------------|--------------------------|
| Soil horizon A   | B1       | B2                                   | BC                       | A            | B1       | B2       | BC       |
| Clay             | -39      | -                                    | -                        | -            | -        | -        | -        |
| B1               | -6       | -                                    | 0.03                     | 0            | 0        | -        | -        |
| B2               | -11      | -                                    | 0.6                      | ++           | 0.5      | ++       | -        |
| BC               | -6       | 0.5                                  | 1.7                      | ++           | 1.5      | ++       | 0.7      | ++       | -        |
| C                | 29       | 0                                    | 2.5                      | ++           | 2.2      | ++       | 1.6      | ++       | 0.3      | ++       |
| A                | -        | -                                    | -                        | -            | -        | -        | -        |
| B1               | 0        | -                                    | 0.01                     | 0            | 0        | -        | -        |
| B2               | 6        | 0.5                                  | 1.0                      | ++           | 0.4      | ++       | -        |
| BC               | 29       | 0                                    | 3.0                      | ++           | 3.9      | ++       | 2.1      | ++       | 0.3      | 0+       |
| C                | 12       | 26                                   | 1.1                      | ++           | 2.1      | ++       | 1.2      | ++       | -        |
| A                | -        | -                                    | -                        | -            | -        | -        | -        |
| B1               | 3        | 0.1                                  | 0                        | 0            | 0        | +        | -        |
| Fine sand        | B2       | 12                                   | -                        | -            | -        | -        | -        |
| BC               | 8        | 2.6                                  | -                        | -            | -        | -        | -        |
| C                | 5        | 6.3                                  | -                        | -            | 9.4      | -        | 4.6      | -        | 0.7      | -        |
| A                | -        | -                                    | -                        | -            | -        | -        | -        |
| B1               | 3        | 0.4                                  | -                        | +            | -        | -        | -        |
| Coarse sand      | B2       | 20                                   | 2.5                      | ++           | 1.1      | 0        | -        |
| BC               | 0        | 1.4                                  | -                        | 0            | 0.3      | ++       | 1.0      | +        | -        |
| C                | 0        | 2.4                                  | -                        | -            | 0.5      | ++       | 1.2      | +        | 0.7      | +0       |

*Note: value of information divergence and two signs represent change of accordingly, minimum and maximum of variation: - decrease; + increase; 0 not change.

4. Conclusions
In this paper the probability distributions and statistical entropy and information divergence of granulometric fractions contents in Kashtanozems at the south of Western Siberia are investigated. We consider these probability functions as statistical standards of granulometric composition for investigated territory. They permit comparing data on soil texture in different horizons, various soils across close and remote territories. Regularities of change of probability distribution and scale-independent information characteristics allow numerical assessment of influence of processes of
sedimentation, weathering and soil development also geological and contemporary deflation and anthropogenic impacts on probability structure of granulometric fractions contents. This approach is useful for more adequate quantitative assessment of mutual results of natural (and anthropogenic) processes which are reflected on structure of variation of soil properties.

Changes of probability distributions and statistical entropy of properties of soils are used as criteria for estimation of natural and anthropogenic processes of contemporary soil evolution. Stability of soil is considered, as the ability to keep properties and the structural organization within the limits of natural variability at external impacts. It is theoretically and factually shown, that steady conditions of granulometric composition of soil, are characterized by the minimal changes of statistical entropy by module. Granulometric composition shows stability under deflation and a long usage in arable land, but its probabilistic structure is not stable under impact of irrigation.

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