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Temporal Barriers in Virtual Nature Systems: View the Past and the Future

Abstract: Field experience and digital analysis of Nature Systems confirm their belonging of the Actual Nature Systems (ANS). The ANS may presents river basin(s), coastal zone(s), and others as the Open Non-Equilibrium Nature System. The following elaboration of the Virtual Nature Systems (with VNS) has also purpose to research the ANS (Prigogine, 1984) in action. The objective is how to evaluate the Past and the Future of the ANS.

The ILL is the temporal barrier, which distort the Past by generation of false trends. However, dissipation of system's memory over a whole system makes a hope to restore the history after recognition of external (tectonic and climatic) influences. The second task is evaluation and views the Future for an area by the Virtual System through reforming of external influences to processes in the ANS by the VNS. The real time input of observed external influences turns the VNS to the Moving Digital Earth (MDE). The MDE always estimates the nearest Future by delay of the ANS on the external influences. Quick computing provides outstripping view for hazardous (floods, debris flows, and others) and background processes.

Attempt to view the Future appears second temporal barrier, because of continue of external factors distort view the Future state and events (floods, debris flows, and others). This barrier location depends on deficiency of knowledge on earliest 2D external reasons. Nevertheless, the MDE is de facto the Time Machine, which produces view the Future.

Keywords: virtual nature system, temporal barriers, Information Loss Law

1. Introduction

The foundations for the View the Nature are as follows:

- Nature System is really belonging to Open Non-Equilibrium Nature Systems, which are described by non-linear Thermodynamics' by I. Prigogine (2)

- Practical foundation for investigation of the ONS is field experience on river basins and their Components: River terraces, terrace ranks, terrace complexes, and others, in problem of research Natural Systems Dynamic in conjunction to practice: assessment of seismic activity, hazardous accidents, and others.

- Theoretic foundations are methods for mathematical modeling of nature Systems and there components by statistic, deterministic methods. Objects of investigation are 2D Open-non-equilibrium Nature Systems – ONES (river Basin of any size and structure of flows and Coastal zones of seas under dynamics under influences of wind and current. The ONES has important properties (multiple dimensions, multiple factors, spatial distribution of variables and parameters). These are objects for human activity (dams, reservoirs, and land use of any kind, relief engineering, and contamination spreading and protection. Objects are major environmental processes (soil erosion, sedimentation, erosion and slope processes, sea-coastal zone abrasion/sedimentation, snow covering and melting, glaciers, and all major Geomorphology processes, surface-underground water flows and interactions, which are to be developed in the project as environment influence on humanity, and human safety against disastrous processes. The Nature systems are always by influence of external factor from bordering nature systems (Meteorology, Geodynamics), as on system's drivers. The general objectives are restoration of the Past, forecasting, and recognition of future Disasters**.**

2. Sources of data

Governing sources of data are Natural Records as information for exogenous and endogenous Geodynamics. Endogenous and exogenous influences on natural systems may be separate, by usually are simultaneous (acting together) in various spatial-temporal combinations. These influences are reasons and drivers for Earth natural processes, for water/sediment/energy flows through natural systems. Sediments and other natural records reflect a history of natural system and history of external influences (climate and tectonic variations, oscillations, and trends). Trends and oscillation of records are foundation for prognosis and for reconstruction of the Nature system and its changes both by extrapolation of trend, and by restoration of past regime (it is way and source of decisions). Therefore, necessary that record are true. Sources of natural records are sediments, terrace ranks, and complexes in area of erosion, any combines of them. **Terrace rank** is determined as a graph of number, height, and width of river terraces (former riverbeds) on a cross-section9s) of a valley. **Terrace complex** is determined as a row of cross-sections along a river valley, include its sediments. Terrace rank is source for data on a history of an area. Terrace complex is major method for search and truly recognition for local and common tectonic deforming of the Earth together with geologic

data. Terrace ranks and terrace complex in areas of erosion are genetically connected with sediments in areas of sedimentation.

Natural records and their spatial temporal trends are source of information on climate and tectonic influences, foundation and data of climate change. Deforming of terrace complex is foundation for local tectonic deformation, for assessment of seismicity. Tasks for Natural record analysis is restore a history for Climate and Tectonic**.** The field observations were caused by practical task to assess a threat for tectonic movements and earth crust distorts on earthquakes. The continual aim is answer on questions on Place, Time, and Power of earthquakes and climate history for future hydropower stations (and their dams) in mountainous regions. These three questions were never answered simultaneously (only any pair of them) because of deficiency of knowledge on external spatial-temporal processes (as reasons), and on response of these influences on Earth processes. This knowledge is the major objective for Geodynamics and Geoinformatics of earth systems and processes in these systems. The geomorphology researched natural records and interprets it by methods of Geophysics, Geography, PalaeoGeography, and others.

The group of scientists researched terrace complexes in Southern Siberia (Klenov, 1966)**,** in Far East, Than Shan, and all others for the purpose to and determine criteria for recognition of active zones of Earth core, in view to assess threat of earthquakes' power and frequency. The geomorphologic methods for regional researches are in conjunction with parallel geology observations, and in parallel to geophysical methods for observation of earthquakes inside earth crust or deeper. The main purpose was assessment of earthquake's danger in areas of building of large hydro-stations, in building of dams for large reservoirs. Geomorphology part of this work includes regional measurement of terrace ranks, terrace complexes, and their tectonic deformations. For the purposes were observed and measures terrace ranks and terrace complexes, which were interpreted opposite to commonly accepted opinions, from independent point of view.

Hypothesis on statistic mechanics of terrace ranks suddenly appeared after long time traditional field experience, direct interpretation as important parts (fragments) of a history. The restoration of a history was (and is) under influence of dominating concept that terrace levels are result of climatic changes during the time, and under regime of tectonic movements. The field experience does not confirm to this point of view. Observed Terraces ranks and complexes demonstrated a 'wild dancing' of levels, which look like variations of height, longitude, and number of the levels along valley. Instead of strong following of observed terrace ranks in practice dominated missing trend due connection fragmentary levels by approximately equal heights to 'regional' or 'cycle' terraces. The more or less height of neighbor local levels was accepted that they have similar age; propose were and then accepted were that these 'prove' that local levels are reapers of a history, due low exactness

for the existing methods of the PalaeoGeography (Klenov, 1983). Even contemporary exact method is not widely accepted, because of analysis of the sediments' age on all fragmentary levels is too expensive. Proposals were continually turned in proves. It was accepted that levels of equal height are accepted as simultaneous. Usual explanation of bad quality terrace correlation in height was that most of regions are covered by forests and visual following up of level often unseen.

Task for Geodynamics and Geoinformatics is losses of a history in natural records. The processes of rivers evolution require assessment of measure of terraces lost during a time, to restore of real regimes.

This is the main problem of the Geoinformatics and Geodynamics due the Information Loss Law (ILL) widely usually known 'in common', but it always not analyzed by statistics for spatially distributed objects and probability. In addition, were silently ignored in all Palaeotectonics and Palaeoclimatics reconstructions. It is because the attention of researches concentrates on visible former forms, sediments, and tracks. Destroyed tracks of past event and non-observed tracks of them were ignored. This is main problem and main objective for the Geodynamics and Geoinformatics of nature systems (Klenov, 2008).

Observed properties for Natural records are supported or rejected by their statistic modeling. Operation for statistic modeling includes generation for statistic ranks with varied properties, as follows:

1. Independent terrace ranks do not correlate with neighbors; each terrace rank was modeled as process under variation for parameters as follows: step of river cutting, sharpness of slopes, variation of cutting position in previous between bed edges; generation of stochastic regime of erosion/sedimentation, among many others.

2. Major property of the terrace rank (cross section) is in that their quantity and common properties are essentially independent on actual history for changes of riverbed width**,** by oscillations and trends of a riverbed width, on common number of levels on a row of separate cross-sections.

3. Ranks of river terraces do not keep a whole history. They keep only a system's Geodynamics, exposed are stochastic mechanics resulting if safety for moments of a history, which does not coincide with possible regularity and trends n actual history.

Statistic modeling for structure and dynamics for terrace ranks was done from the proposal for dynamics of the records in time. For the purpose were worked out many statistic models with various external factors, with following recognition of these structures in river valleys and with a variety of scenarios for tectonic ('smooth' and 'sharp') d) and climatic oscillations. Statistic modeling for structure and dynamics for terrace ranks was done from the proposal for dynamics of the records in time. For the purpose were worked out many statistic models with various external factors, with

following recognition of these structures in river valleys**,** and with a variety of scenarios for tectonic for common and local tectonic deforms.

3. Numerical experience

Many statistic models for terrace ranks were worked out by generation of stochastic processes and by experiences parameters. The convenient method was chosen as statistic modeling of stochastic processes. The hypothesis is that terrace forming is result of stochastic processes. The basic proposals are as follows:

1. Cutting of a river in process of river valley evolution corresponds with stochastic oscillation of riverbed width. Interval of valley cutting is proposed as constant (and later proposed as stochastic).
2. A width of riverbed is a value of stationary stochastic process with given law of distribution.
3. Fractions of the riverbeds, which was in the width more of all following ones, are preserved as terraces.
4. Cutting of a river bed in any next bottom are proposed with stochastic lift of right displace, in accordance with meandering and branching of a stream in real rivers.
5. Sharpness of both slopes (left and right) is a parameter.

4. Results of numerical experience.

. In a many terrace ranks, the number and heights of terraces are measured and they are compared with computed. Comparison for statistic and observed terrace level series shows their similarity in structure (number of levels and distribution on valley' slope. Processing of computed terrace ranks and compares them with many observed terrace ranks helps to establish dependence of terraces happening in dependence of their height. Commonly, the dependence of observed and computed distribution of terraces on their height is equal. In any single terrace rank, both observed and modeled the number of level and their height is strongly variable:

Stationary stochastic satisfactory explains all observed facts. The preliminary conclusions are as follows:

1. Mechanics of terrace forming and destroy in process of river cutting down results in that most of riverbed oscillations does not fixed in terraces. Most of history is lost nonlinearly.
2. The proposed statistic model is founded on own experience. It shows that even s t a t i o n a r y stochastic process for riverbed width oscillations is always fixed by modeled terrace rank as a trend for decreasing of the width oscillation amplitude during valley cutting. Terrace rank not only losses most of former levels, but also distorts itself.

3. Terrace ranks in mountains have the same empiric laws in intermountain depression, where sedimentation does not form uninterrupted natural records by multiple replace of sedimentation in space and remove of former layers.

4. The direct interpretation of the observed nature records makes a false view to history, false trends in the history (Figure 1).

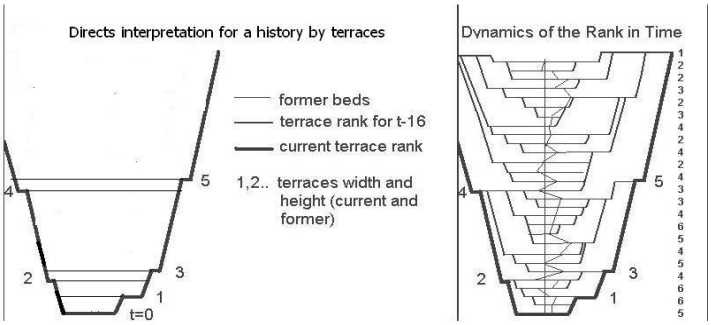

Figure 2. Alternative views on a history: direct (left), by dynamics (right)

Structural identity of actual and computed terrace complexes is seen by comparison of numerous measure terrace complexes is obvious, by direct observation and by numerous modeling. Most of observed and computed terrace complexes in mountain regions are the same properties as their fragmentarily. However, observed complexes do not contain loosed information, and statistic ones contains it. It is only hypothesis, but in confirms to all observed data. The natural history, due to non-linear information loss in the Past, the history is almost blank. The small observed part does not consist a history, but only its stochastic fragments, selected by dynamic of natural system – terrace Ranks and Terrace Complexes, They not only loss the Past, but distort view on it**.**

Trends in observed and modeled terrace levels (increasing of height differs from lower level to upslope) is reviewed from lowering of valley cutting to properties of rivers geodynamics**.** The modeled process of terraces ranks change during the time was compared with observed and measured terrace complexes in mountain/intermountain regions (Sayan, Than Shan, and others mountains). Which in that the natural records of sediments and forms do not present real history, which makes illusion of trends? Therefore, natural records cannot be used for estimation of real natural trends. The more or less satisfactory records were written in past historical time, by regular observing on hydrology and meteorology gauge stations. In other words, in blanked natural record may be inserted any quantity of events oscillations and trends.

The Statistic models are not system' models, because these do not assess values and balance of processes. Long time experience on the System Analysis was not quantified. It resulted in that in any Nature system prevail interactions and backspaces between all their components, which was impossible to calculate. Only with appearance and quick growing of computer technology, of powerful computers becomes possible direct evaluation of processes in nature system, their dynamics, and evolution (including assessment and upgrade of Information Loss Law)**.**

Information Loss Law is major temporal factor for the GeoInformatics of natural processes. Join of statistics modeling of geomorphic processes resulted in the following:

- Natural records a history of oscillations and make false trends.
- Natural records none linearly loss most of history.
- Natural records (and their organic content) cannot restore a single history due multiple interpretations of these records.
- Representative is only human measured records (with correction on change methods).
- Nature is compound of statistic processes, which cannot be presented by deterministic models.

Terrace ranks are opposite sediment complexes. These are set upstream and downstream correspondingly. Observed and modeled properties of terrace rank determine properties of sediments. This opinion is in conform (opposite and fragmentary) to modeled regime of denudation in river valley**.**

In reality terrace ranks has complex structure. They contain alluvial sediments. There together with prevailing cutting were was more or less long periods of sedimentation. The alluvial sediments are almost on all terrace levels. In piedmont and in depressions the thickness of the sediment is compatible or exceeds terrace's height, or even form buried terraces. The question is about terrace memory for a whole history, not only in erosion terrace ranks but even in erosion –sedimentation terrace complexes How full the complex ranks reflect and 'remember' the history, and what part of it is saved in forms and sediments is saved?

5. Conclusions

1. Statistic modeling of Terrace complexes rank does not constrain to multiply observed actual terrace Complexes. These complexes distort actual history.
2. In process of dominating cutting down is a continual reforming and 'cutting' of a whole complex, where remembered are only moments of history, under prevailing mechanics of history losses.

3. The sample and the special model demonstrate mechanics for placers, which were formed under multiple removing for observed concentration in a one of a few streams.

The Information Loss Law looks like a probability of terrace safety (P_h) on a height *h* is presented by empiric equation $P^h=h^{-B}$, where *B* depends on sharpness of slopes and on displace of a stream to left or right board. Partially, if lateral displace is absent, and sharpness of slopes is 90^0 ,then $B=-1.s.$

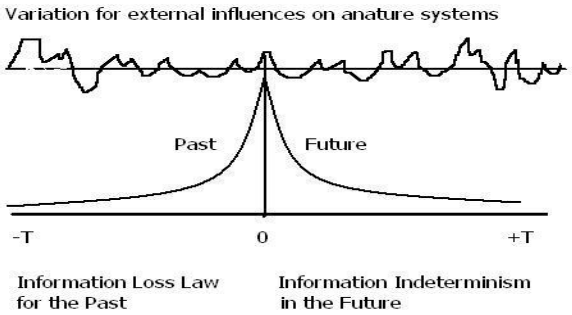

Figure 2. How the ILL change for a view on the Time.

The **Information Loss Law is the outcome for Nature Systems Geodynamics of processes.** This memory has non-linearly lost own memory by continual stochastic process of former levels destroy (remove). The process of river valley Deeping is combining of two simultaneous processes – origin of terraces and destruction of former level. In the rank continually contains between 3-4 (2-5) levels.

The ILL changes properties for prognosis and restoration of the ANS (Figure 2). All other natural records are under the ILL. The VNS is a new tool for knowledge, how the Geodynamics is reflected in the time, or how receives information of the Past and of the History of the Environment. The widespread opinion is that information losses in time remove the Past. However, the necessity in analysis of the Nature system Geodynamics requires receiving Information on Geodynamics. The past processes, their variability and trends are vitally for tasks for the Environment and included information of past event, trends of geodynamics and climate; it determines human's response on the trends, on prevalent opinion on a hazardous climate warming. It is yet a question, what is a part of nature trends, and part of human activity. The past events are written in natural Databases about the Past – in sediments in various media, and in forms of relief. Processes of Geodynamics in the time are

responsible for safety and destruction of past data. Revision of natural databases is necessary. Note that it is impossible to fill up blanks in records due stochastic regime of most natural processes. Statistical Autocorrelation/spectral analysis of observed records (water level, discharge, thickness of a tree rings, precipitation, and others) shows that meaningful periods (with very small exactness) exist in the records only for few steps. It makes widely used method of statistic extrapolation not available for high frequency oscillations. The method for evaluation of trends has high barrier that for the purpose measured records are too short for statistic validity of long-term oscillations.

The ILL determines both temporal barriers. In the past barrier is in terrace complexes and in sediments. One way to overcome it is in use method for step-by-step restoration of past influences with their checking by the VNS (Klenov, 2008) by the VNS running ahead and compare of estimated and actual influences and systems state. In the Future Barrier will exist until by knowledge of the drivers in the Future, what is not yet possible with high 2D exactness. However the ILL permits outstripping monitoring of the nearest future. It is extremely important, because evaluation is done for all area, including sites and tracks of hazardous flows, what probability of event by cumulative mapping of their tracks, what is measure of danger in a lot of practical tasks (urgent warning, mapping of threats and their danger, et al. This depends on 2D plane structure of external impacts, on properties of Nature systems (distribution of weak soils, on location of all vulnerable sites in area, overlapping of 2D external impacts (storms) with areas of earthquakes, with area of dense population, with areas of tectonic distorts, and so on). This task is difficult, but is reliable in outstripping monitoring, and in real time evaluation for current and experienced threats. Expected is, that properties of the VNS (in action it is Changing Digital Earth (CDE) will only increase. Therefore, installation, training, and outstripping monitoring by the VNS should be done now.

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