The complex system of environmental monitoring (CSEM).
An analysis of concept

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Abstract. Researches of ecological processes in Russia testify to rather difficult and adverse situation. It is quite obviously that we need a reasonable concept of an exit from the situation. It could become the strategic program for the solution of ecological tasks at the same time. In this regard, it is obviously necessary not just to develop new scientific and technological mechanisms to overcome of critical situations, but to offer a new research platform which will be able to give ideas to predict tendencies of ecological development and to analyses the consequences of their embodiment. Our offer for it is "the composite system of environmental monitoring" (CSEM) of the territory or region. We use a method of the conceptual analysis. Also, we will try to show how definition of the term influences to contents of social practicing, namely, environmental monitoring of the region.

1. Introduction
Western Siberia is dynamically developing region, but traditionally there was the difficult ecological situation. In recent years, the regional authorities pay to ecological safety much attention, but nevertheless, measures for the solution of ecological contradictions demand deeper systematic conceptual study. It is apparent that the solution of these problems demands an integration of various areas of researches: naturally scientific, technological, mathematical, political, etc. (About a research of integration approaches to the solution of eco-social problems see: Baumgarten M. I., Mitchenkov I. G., Galanina T. V. Environmental monitoring as the instrument of sustainable development. November 1-2, 2012 Natural and intellectual resources of Siberia – SIBRESURS, 2012. Materials of XIV International Science. Conf. Kemerovo, Russia. Page 169-171; Baumgarten M. I., Mitchenkov I. G., Galanina T. V. The conceptual framework of environmental monitoring. 2013 Materials for the 9 International Scientific Conference "Новинатазисапреднилауака". Vol. 48. ЭКОЛОГИЯ. (София: БялГРАД-БГ). Р. 50-56; Mitchenkov I. G., Mikhaylov V. G., Baumgarten M. I., Taylakov A. A., Sarapulova T. V. Use of WEB technologies for realization of a technique of estimation of environmental problems. 2013 Vestnik of Kuzbass State Technical University. Vol 4. Pp. 136-139; Baumgarten M. I., Galanin T. V. About adequacy of mathematical model to the database of ecological parameters 2014 October 16-17 Materials of Scientific Conference "Informational and Telecommunication Systems and Technologies". Kuzbass State Technical University. Kemerovo. Pp. 353-354). It will provide a possibility of creation of complex system of monitoring of an ecological situation. At the same time formation of the uniform concept capable to submit the complete program for stabilization of a situation and realization of environmental policy, is possible only on condition of its philosophical and theoretical justification. Such approach is especially urgent when forming uniform policy on leveling of ecological contradictions in regional aspect. It is about the complex system of environmental monitoring (CSEM) of the region which is a point of bearing for formation of positive model of the ecological development and environmental relations.
At the same time, it should be noted that the concept of "monitoring" is not defined conventual, possesses big degree of a theoretical ambiguity and means a philosophical concept, then the settled scientific concept rather.

2. Critical review of concepts and justification of CSEM

Follows from the review of the Russian sources that the concept "monitoring" gains various sense depending on to what object, what phenomenon or process it belongs. (Izrael, Yu. A. Ecology and monitoring of a condition of the environment. 1984 (Moscow: Gidrometeoizdat); Hotuntsev Yu. L. Ecology and ecological safety: studies. 2004 (Moscow: Publishing center "Akademiya"). 2nd ed.; Bondarik, G. K. Engineering-geological researches. 2007(Moscow: KDU)). In the most general view, proceeding from word etymology, monitoring means keeping track of by some objects or the phenomena. It is fair also in relation to the Western sources [1]. Since there is an incalculable set of the phenomena, processes and objects, it is necessary to believe existence of the concept "monitoring".

Synonyms: observation, tracking, assessment, forecast.

Let's note that monitoring can be carried out at the different space levels, defined by the tasks set for monitoring: global, regional, local. Here a difference only for monitoring, methods of collection of information, volume of the obtained data and ways of their processing. In the same way monitoring, can be carried out at the different temporary levels: the continuous, daily, monthly, annual, periodic (through a time term).

In reference books, it is possible to allocate three types of interpretation of the concept "monitoring". The first definition, the most common, is bound to word etymology. Definition can be short or developed. For example,

- **Monitoring** – process of tracking of a condition of system or the phenomenon (The Terminological Dictionary of the Librarian on Socio-Economic Issues. 2011(St. Petersburg: National Library of Russia) (http://window.edu.ru/resource/646/64646)).

- **Monitoring** – the technique and system of overseeing by a condition of an object or process giving the chance to observe them in development, to estimate to quickly reveal results of influence of various external factors [2]. Results of monitoring give the chance to make corrections on management of an object or process (The Dictionary of Business Terms. 2017 (http://dic.academic.ru/)). Similar definitions are given “The Encyclopedia of Sociology”.

2017 (http://onlineslovari.com/entsiklopediya_sotsiologii); D.V. Dmitriyev. Explanatory Dictionary of Russian Language. 2017 (http://padabum.com/d.php?id=41428).

The second definition is directly bound to monitoring of the nature (a surrounding medium, the environment, etc.) since for the first time it was offered for the description of system of repeated observations of one and more elements of the environmental environment in space and in time with definite purposes per in advance prepared program. (The similar comprehension can be met, for example, in work Izrael Yu. A. Ecology and monitoring of a condition of the environment. 1984 (Moscow: Gidrometeoizdat).P. 176). It can also be short and more developed, for example:

- **Monitoring** – (in Latin “monitor” means “supervising”) – is the system of long-term overseeing by change of ecosystems (ecological) and biospheres (biosphere monitoring). It is made at express stations (including hydro meteorological) and in biosphere reserves [3] (Very similar definition is given in "The Ecological Dictionary". 1983. (http://ecologylib.ru/books/item/f00/s00/z0000003/index.shtml)).

- **Monitoring** – is a complex of the observations and researches defining the changes in a surrounding medium caused by activity of the person (The Terminological Dictionary of Bank and Financial Terms. 2011 (http://www.2buh.ru/slovar/financial/32522.html)).

- **Monitoring** – 1) is a complex of the observations and researches defining the changes in a surrounding medium caused by activity of the person; 2) is overseeing by state of environment (the atmospheres, hydrosphere, other geospheres, a soil and vegetable cover, fauna, technosphere objects) for monitoring and the forecast of its state, and protection. Distinguish global, regional and local levels of monitoring. It is carried out by means of space, air, land and sea
tools; 3) is keeping track of by any object or phenomenon; in the annex to the life environment - keeping track of by its state and the warning of the created critical situations (increase in a gas contamination of air over threshold limit values, etc.), harmful or people hazardous to health, other living beings, communities, natural and anthropogenesis objects (including constructions); 4) is the system of the regular long-lived observations in space and time giving information on state of environment for the purpose of assessment of the past, the present and the forecast in the future of the parameters of a surrounding medium important for the person. At the national and regional levels the organization of monitoring is assigned to the appropriate executive bodies and is regulated by the relevant acts and resolutions. Trial functions of monitoring are quality control of free air, water, the soil, etc. landscape components; definition of the main sources of pollution; prediction of a condition of quality of principal components of a landscape and t of the item. (The Ecological Encyclopedic Dictionary. 2009 (http://www.cnshb.ru/AKDiL/0039/base/RM/005606.shtm)).

Similar definitions are given in the following sources: Ecological Dictionary. 2017 (http://gufo.me/ekoslov_a); Dictionary of ecological terms and definitions. 2017 (http://www.mnr.gov.ru/regulatory/detail.php?ID=143951); Big Encyclopedic Dictionary. 2000 (http://www.onlinedics.ru/slovar/bes.html); Modern encyclopedia. 2000 (http://7tor.org/viewtopic.php?t=1019264); Biological encyclopedic dictionary. 2006. 2nd issue. (http://istudy.su/biologicheskij-enciklopedicheskij-slovar-m-s-gilyarov-1986/); Encyclopedic dictionary. 2009 (http://gufo.me/bes_a); Natural sciences. Encyclopedic Dictionary. (http://estestvoznanie.slovaronline.com/); Civil Protection. Conceptual and Terminological Dictionary. 2001 (http://ivanov-am.ph/manual_slovar/index.html) and others.

The third definition is synthesis of two first:

- **Monitoring** – 1. Observation, assessment and the forecast of state of environment about economic activity of the person; 2. Systematic overseeing by some process with the purpose to fix compliance (or discrepancy) results of this process to tentative assumptions (Krysin L. P. The Explanatory Dictionary of Foreign Words. 1998.(http://megabook.ru/search?SearchText=); Efremova T.F. Explanatory Dictionary. 2000 (http://www.efremova.info/)).

- **Monitoring** – [English monitoring]. System of constant observations, assessment and the forecast of what change of a state - M. object natural, social, etc. System of monitoring. (Big Dictionary of Foreign Words. 2007. (http://www.bankreferatov.ru/db/B/8EFFE5C2A0CD1A79C325783400717D14#WLkcbIV OK00)).

- **Monitoring** - 1. Constant overseeing by any process to detection of its compliance to desirable result or tentative assumptions. 2. Observation, assessment and prediction of state of environment about economic activity of the person. (Modern Dictionary of Foreign Words. 2015;Modern dictionary of foreign words. 2000).

Similar definitions are given in: Big Legal Dictionary. 2010 (http://www.twirpx.com/file/1134890/); Beginnings of the modern natural sciences. Thesaurus. 2016 (http://www.alleng.ru/d/natur/nat016.htm); Big Explanatory Dictionary of Russian. 2016 (http://www.gramota.ru/slovari/info/bts); and others.

Presence at the concept "monitoring" of a polysemy and infinity follows from the above-stated definitions. Perhaps, for the first time the mathematicians trying to construct mathematical models of monitoring [4] faced this ambiguity. Especially brightly it can be seen by consideration of concrete types of monitoring [5]. Let's try to make some classification and structuration of a set "monitoring".

At first, it is possible "to divide" monitoring on:

- Monitoring of objects.
- Monitoring of the phenomena and processes.

Then "to divide" monitoring of objects on:

- Monitoring of the nature.
- Monitoring of society.
Monitoring of the nature is subdivided on:
- Monitoring of the atmosphere.
- Monitoring of the hydrosphere.
- Monitoring of the lithosphere.
- Monitoring of the biosphere.
- Monitoring of the Universe.
- Monitoring of the techno sphere.

Monitoring of society can be subdivided proceeding from monitoring of the main social institutes (table 1):

| Main social institutes | Institutes of the lowest level (selectively) | Types of monitoring |
|------------------------|---------------------------------------------|---------------------|
| Economic               | Industry, agriculture, trade, property, financial system, market, exchange, marketing, management, banking system, etc. | Informational, a banking system, an exclusive economic zone, profitability, control devices in audit, electronic databases, objects of town-planning activity, etc. |
| Political              | State, party, social movement, army, police, parliamentary, presidency, court (legal profession, prosecutor's office, refereeing), civil society, etc. | Public opinion, law enforcement in the Russian Federation, ethnological, etc. |
| Cultural               | Church (religion, monkhood, confession), (spiritual sphere education (school, the higher school, average professional), science, institutions of art (theaters, museums, clubs, libraries), etc. | Media, social media, a state and use of historical and cultural monuments, in education, etc. |

Then monitoring of society is subdivided on:
- Economic monitoring.
- Political monitoring.
- Social monitoring.
- Cultural monitoring.

Monitoring of phenomena and processes can be subdivided on:
- Monitoring of climate.
- Monitoring of accidents.
- Monitoring of pollutions.
- Monitoring of global habitat condition.
- Monitoring of information and others.

Each of them is in turn subdivided into more detailed types of monitoring. Let’s note that in literature, especially help and encyclopedias, more than a half of definitions of the concept "monitoring” is bound to a surrounding medium (the nature, the biosphere). Often monitoring of a surrounding medium is equated to environmental monitoring. (For example, similar approach practices in encyclopedia online "Academy": http://dic.academic.ru/). “Monitoring” (in Latin “monitor” means “reminding”, “supervising”) – is keeping track of by some objects or the phenomena. Usually mean complex system of observations, assessment and the forecast of changes of state of environment under the influence of...
the person by monitoring” [6]. (Rather exponential example of a similar definition can be found in Masur 1. I., Chumakov A. N. Global Studies: Encyclopedia. 2003. (Moscow: JSC Publishing House Raduga).

Several other interpretations of the concept "monitoring" is given in the popular Internet encyclopedia "Wikipedia”. Mean by "monitoring”: – system of collecting/filing, storage and analysis of a small amount key (apparent or indirect) signs/parameters of the description of this object for removal of judgment of a behavior/condition of this object in general. That is for removal of judgment of an object in general based on the analysis of a small amount of the signs characterizing it.

In the Western sources of a concept monitoring most often has the following values:

**Monitoring** – is process of observation and data recording about any object on the time slices which are indissolubly adjoining to each other during which values of data significantly do not change (in the same place). Distinguish Monitoring of parameters and Monitoring of a condition of an object. Monitoring of parameters – overseeing by any parameters. The result of monitoring of parameters represents set of the measured values of the parameters received on the time slices which are indissolubly adjoining to each other during which values of parameters significantly do not change [7].

**Monitoring of a condition** – is overseeing by a condition of an object for definition and a prediction of the moment of transition to the limiting condition. The result of monitoring of a condition of an object represents set of diagnoses of the subjects making it received on the time slices which are indissolubly adjoining to each other during which the condition of an object significantly does not change. The fundamental difference of monitoring of a state from monitoring of parameters is existence of the interpreter of the measured parameters in terms of a state – expert system of support of a decision making about a condition of an object and further management [8].

**Monitoring** – is systematic data collection and processing which can be used for decision-making process improvement, and, indirectly, for informing the public or just like the instrument of feedback coupling for exercise of projects, assessment of programs or development of policy. It bears one or more of three organizational functions:

- Reveals a condition of the critical or being in a condition of change phenomena of a surrounding medium concerning which the course of actions on the future will be developed.
- Establishes the relations with the environment, providing a feed-back, concerning the previous achievements and failures of policy or programs.
- Establishes compliances to rules and contractual obligations [9, 10].

At such approach "monitoring of objects" is equivalent to "monitoring of object state", but "monitoring of processes and phenomena" - to "monitoring of parameters".

From definitions, it is visible that the concept "monitoring” is the composite, matters both as systems and as process, and depends on object of studying[11]. Systemic orientation of the concept “monitoring” is reflected in the following definition:

**Monitoring** (in Latin “monitor” - is the one who reminds prevents - monitoring) – is the complex system of the regulated periodic observations, assessment and the forecast of changes of a condition of the environment with the purpose of identification of negative changes and developments of recommendations about their elimination or easing. Monitoring as a multi-purpose information system includes: the bioenvironmental monitoring studying the environment from the point of view of its influence on the state of health of people; the geosystemic, or natural and economic monitoring studying changes of geosystems (including natural) of which the surrounding medium (geo-monitoring) consists; the biosphere monitoring providing observation, control and the forecast of possible changes of the environment on a global scale (bimonitoring). Monitoring of the geological environment is called a “litho-monitoring”. (This definition is taken in the Kozlowski E. A. and other. Mountain Encyclopedia. 1984 – 1991 (Moscow: Soviet Encyclopedia). In 5 volumes. Vol.3, 1987. Page 391. It should be noted that for naturally scientific approaches it is typical).

Considering the above, and relying on our characteristic idea of the maintenance of the concept “monitoring” developed based on integrative and comparatists approaches to the above definitions, we will shortly consider key parameters (algorithm) of the complex system of environmental monitoring which is the practical embodiment of substantial aspect of the concept "environmental monitoring".
So, an object of a research of social-and-ecological monitoring are: eco-social aspects of environmental problems of the region;

- research objectives: creation of complex model of regional social-and-ecological monitoring. To designate philosophy of innovative environmental policy and mechanisms of its realization in the Russian Federation;
- research problems at a starting stage: to analyses environmental problems of the region; to investigate regional tendencies in the sphere of nature protection and environmental management; to develop mathematical model of regional environmental monitoring;
- range of application: results of a research can be used during creation of plans of economic, social and ecological development of the region;
- competitive advantages: lack of similar works;
- principal specifications: the project assumes creation and use of databases on ecological and economic indexes of development of the Russian Federation, in parameters and indicators of sustainable development of the region; creation of mathematical model of environmental monitoring of the region; creation of model of the complex analysis of environmental monitoring of the region;
- tools of research: computer programs for processing of statistical data like SPSS or Statistic; IDEFO Standard as basis for creation of the functional and structural and analytical models for generalization, systematization and descriptions of interrelations of the composite systems; methods of expected researches; methods of optimization of parameters;
- result of a research – creation of mathematical model of the regional eco-social indexes.

The explained algorithm of "environmental monitoring", from our point of view, fullest considers the volume and the maintenance of the concept "monitoring" and removes indeterminacy at its use in the sphere of ecology. In too time, this definition sets the program content of activities for prevention and sanitation of eco-negative consequences. This activity is made out as complex system of eco-social monitoring.

3. Conclusion

Thus, the standard concept "monitoring" completely is defined by expression "keeping track of any objects or the phenomena". At the same time both temporary, and space coordinates implicitly are meant. Separate consideration is demanded by a question of objects of monitoring. If on an incipient state (the 70th – the 90th years of the 20th century) the main object of monitoring, it is rather a field of close attention, there was the environment, then it both economy, and pedagogics, and media, and sociology, and other areas of human activity now. In definitions objects or processes, but all of them – "monitoring" is concretized. It means that when using the term, it is necessary to concretize every time an object, the phenomenon of monitoring, the purpose and ways of its realization. Results of this work can promote more complete comprehension of volume of the concept "environmental monitoring" and those processes which constitute the maintenance of the ecological development and environmental relations, and mechanisms of their reforming and regulation. Also, results of a research can be applicable at correction of regional environmental policy and coordination of the measures directed to overcoming the ecological and social centers of danger (based on the offered eco-monitoring algorithm). The presented algorithm of the complex system of environmental monitoring (CSEM) will help with development of the innovative environmental policy capable to influence design the relation of the person to a surrounding medium, including in realities of the old industrial centers.

References
[1] Shanno C.E. (1948) July & October 1948 A Mathematical Theory of Communication. Bell System Technical Journal 27 pp 379-423 & 623–656.
[2] Guariso G., Hitz M., Werthner H.1996 An integrated simulation and optimization modelling Environment for decision support Decision Support Systems pp. 103–117
[3] PielkeR.A.1984 Mesoscale Meteorological Modeling(New York: Academic Press)
[4] Graham W.R., Peraire J., Tang K.Y.1999 Optimal control of vortex shedding using low–order
models. Part I: open–loop model development. *International Journal of Numerical Methods in Engineering* **44**(7): 945–972.

[5] Agoshkov V.I., Ambrosi D., Pennati V., Quarteroni A., Saleri F. 1993 Mathematical and Numerical modelling of shallow water flow *Computational Mechanics* **11**(5–6): 280 - 299.

[6] Rinaldi S., Sanderson W., Gragnani A. 1996 Pollution control policies and natural resource dynamics: a theoretical analysis *Journal of Environmental Management* **48**: 357–373.

[7] Arya S.P. 1999 *Air Pollution Meteorology and Dispersion.* (New York: Oxford University Press)

[8] Akbarzadeh A., Ghorbani-Dashtaki S., Naderi-Khorasgani M., et al. December 2016 Monitoring and assessment of soil erosion at micro-scale and macro-scale in forests affected by fire damage in northern Iran *Environmental Monitoring and Assessment* **2016**: 188:699

[9] Soffianian A., Madanian M. August 2015 Monitoring land cover changes in Isfahan Province, Iran using Landsat satellite data. *Environmental Monitoring and Assessment* **2015**: 187:543

[10] Zheng J., Feng X., Liu P., Zhong L., Lai S. 2011 Site location optimization of regional air quality monitoring network in China: methodology and case study. *J. Environ. Monit.* **13**: 3185-3195 DOI: 10.1039/C1EM10560D

[11] Insaf S., Babiker A., Mohamed A., Tetsuya H., Keiichi I., Kikou K. October 2012 Investigating Response of Global Vegetation to ENSO Events Between 1987 and 1997. Using NDVI Data. *International Journal of Environmental Monitoring and Protection* vol. **2**, Issue 5. P. 76-83.