Sustainable Development as Weak and Strong Anticipation Problems

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Abstract:
The general questions of sustainable development: the conception, examples and limitations of implementation are considered. General principles for formalization of notion of sustainable development are discussed that may provide the possibility of introduction of strict definitions of sustainable development. General problem of sustainable development is considered from the point of views of weak and strong anticipatory systems. Some models are considered for study of sustainable development. Relation stability\transformation had been investigated. The consideration of mental aspects comes into question at introduction of sustainable development as one of main problems of transformations.
Keywords: sustainable development, definitions, anticipation, models, indexes

1. Introduction

Recently many environmental, political, economic, and biological studies recognize the importance of sustainability and sustainable development (SD). It is also recognized that an essential part of SD is the evaluation of risks. But it should be stressed that the concept of SD has to date been descriptive without strict formalization.
There are many definitions of SD - in papers, memorandums, declarations, and programs (see for example [1-3]), including Agenda 21 after the Rio de Janeiro Summit in 1992, Johannesburg Summit [4] and 2012 Rio de Janeiro Summit . Since 1992 there have been many advances in developing SD concepts, but it have been many difficulties in formalization and implementation of this concept at the global and regional scales.
At the present time it appears that the SD concept should be merged with a strict scientific background to provide an interdisciplinary synthesis of ideas. The first step towards this scientific approach should be the formulation of new conceptual documents that pose the basis of problems. One of the first examples is The Budapest Manifesto [5], which was formulated at the Euroscience - IUGG Advanced Research Workshop held in Budapest in 2002. It differs from previous documents [3, 4] in that it formulates the problems in more concrete and scientific terms. For example, the Budapest Manifesto stresses the importance of population involvement, decision-makers, social interactions and what we call mentality accounts.
This leads to the development of advanced methodologies for qualitative and

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quantitative analysis. Recent investigations of such problems include system dynamics [6], gaming and simulation [7], case studies [8] and others. But they cannot help to solve all existing problems.

Sustainable development concept is one of general recent problems which have great theoretical and practical importance. Dozens millions of publications are devoted to sustainable development (SD) and related issues (see for example some references in [1-21]). Many definitions of SD exist. The definition by Bruntland's Commission (1987) [3] is most recognized and usable. But this definition is verbal. There exist not very many attempts to give strict definitions of sustainable development. Some examples are investigations in economics [15, 8, 19]. Also some examples had been considered for particular biological problems. It should be stressed that usually in such particular cases the definitions had been based on strict existing mathematical formalization of considered problems. But till now on author's opinion the general strict definition of sustainability and of sustainable development is. But for computer modeling or quantitative decision–making on SD further development and formalization of the concept are necessary. The experience of author in modeling large social system allows proposing the principles for building some new classes of models for such systems (including the general processes of society). Existing of such possibilities in modeling follows to the origin of new propositions for formalizing sustainable development concept and formal definition of sustainability. Moreover, proposed considerations allow proposing some way for understanding and building of sustainability indexes.

In this paper we pose a brief description of a new methodology and some of its applications and prospects for the evaluation of sustainability. We try also to consider some aspects of sustainable development as the basis of new approaches for modeling global properties of society, which can be closely connected to possible accounting of human factors (mentality accounting).

Because of such needs we propose the formal definition of sustainable development which is useful for SD concept of development and applications. Also we describe the role which anticipation plays in sustainable development, especially strong anticipation in global sustainable development. Finally the new prospects for proposed ideas for SD are described.

2. Anticipation and common definitions of sustainable development

The concept of sustainable development has a long history of its essential components. First of all it needs to remark many investigations from natural science and ecology. Another useful part of concept supplies demography (may be since the works of Maltose). First working tool for considering SD is system dynamics since the works of Forrester, Meadows and others. Also important role has played the concepts and the models of the World by I. Wallerstain, B. Fuller, A. Frank. Some pivotal points for SD development was world leaders conference at Rio- de Janeiro (1992), Summit at Johannesburg (2002), and last Summit at Rio- de Janeiro (2012) where some verbal definitions of SD had been proposed and prospects for SD had been formulated.

But the experience since 1992 had followed to necessity of further improvement in

concepts (see many conferences: ESOF – 2002, 2004, 2006 and others). There are many reasons for this. Of course the main are permanent changes in recent world closely connected to global processes. But some intrinsic problems in SD exist which require further development of SD approach. First of all the main accepted definition of sustainable development is verbal and conventional. A little number of quantitative approach exist (system dynamics and some models for modeling large- scales processes, multi- agent approach), indexes of SD. The leak of full operational models follows to the shortage of sustainable development indexes which used for practical planning. So below we propose as the formalization of SD concept as the presumable applications of such formalization, including specific issues.

2.1 Basic description of SD

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
It contains within it two key concepts:
• the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and
• the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."
- following G.H.Bruntland Commission (1987) (see [3]).
That is the discrepancy between the natural resources and between determined by economics and history way of their exploitation exists.
The description of sustainable development above have been used as in global theoretical considerations as in local/regional administrative management [12, 21]. However formalization of the original concept is necessary, especially for the goal of quantitative methods applications: modeling, forecasting, measuring of the progress of SD etc. Below we will pose such a useful formal definition of SD. But before we will describe one non-investigated important aspect of SD – namely anticipation.

2.2 The role of strong and weak anticipation in SD processes

Note here some important issues of SD applications and considerations concerning local and global aspects of SD. Common tools in advanced practice in regional management is using of mathematical modeling for forecasting of processes flows in different fields: ecology, economy, societal. The mathematical modeling in regional planning is used for prediction of possible scenarios for evolution of real natural, technical, social systems. Usually the peoples from real regional management consider the SD as specific 'best' regime in given system operating. Frequently the 'next generation requirements' is omitted. Also usually the local management doesn't means considering of far future. Note that 'long term' prediction is impossible first of all because of intrinsic complexity of such systems. At second it is recognized the principal impossibility of forecasting of single way of development for large socio-technical-environmental systems. So the arguments on 'further generations needs' are more applicable recently in global

theoretical problems.
But SD processes can be considered from the point of view of anticipatory systems, especially with 'strong' and 'weak' anticipation introduced by D. Dubois since 90th [22, 23]. Many formal definitions had been described in the literature (see for example [22-24]). Here we remember one of the definitions which are useful for understanding the role of anticipation in SD.
"Dubois (2000) distinguished between weak anticipation, that is, when systems use a model of themselves for computing future states, and strong anticipation, that is, when the system uses itself for the construction of its future states. In the latter case anticipation is no longer similar to prediction" [24, p. 203].
conclude that 'local management' of SD (with prediction using) corresponds to the weak anticipation properly. But the general SD problem is absolutely different. Just the usual definition of SD above corresponds to the property of strong anticipation for considered systems. That is the long-term behavior of social system can't be predicted. Some of presumable manifestation of anticipatory property for social systems had been described earlier [24 - 27].
Also many applications of such ideas for SD problems can be described for real systems investigations and management practice. Here we only should stress the sustainability of education and scientific system as one of the main issues for SD of any large societal system. For example sustainability of energy industry and energy resources development depends strongly upon the development of new first of all knowledge on physical processes. Just nuclear power plants development depends strongly on the development of nuclear physics.
Thus ideas described in this subsection support the possibilities of further development of formal definition of sustainable development and posing the SD problems on the strict background. So in the next subsections we will consider some of such issues.

3. Formalization of sustainability and SD

3.1 Some factors in SD process

Here we pose the list of some factors of SD which should be represented in the definition of the concept:
Representations of parameters in SD processes; Existing of dangerous trajectories of system in case of fatal restrictions of resources; Possibilities of sustainable trajectories; Possible change of leading resources.

So, the necessary components for SD are:
Resources; Restrictions on resources; Evolutionary aspects; Goal of the system; Existing of many generations; Indexes of sustainability; Decision – making processes; Mental properties of peoples and cultural aspects; Environmental influence; Technologies (recent and future).

3.2 Parameters and structures in SD (list of issues)

Therefore in this section we make an effort to give some primary considering for formalization of the SD concept.
At first we will indicate structures and notions which we should take into account in a problem on local SD.
1. We designate the parameters of the system and their description (external, internal, control etc.) as the set of parameters {Par}. In this subsection we will not consider the details of property of these parameters (and elements of description the following), and only will make an effort to select, what structures should be considered. So, for example, we without the special necessity will not consider possible metrical and topology structures, ordering relations, symmetries and others on the set of parameters {Par}.
2. Equations which describe the systems and processes {Equat}.
3. Set of trajectories of the systems {Traj}.
4. Limitations on trajectories and parameters of the system – set $\{\Omega\}$ and set of boundaries of limitations $\{\partial\Omega\}$.
5. Set of criteria of sustainability {SCrit} or the SD criteria {SDCrit}.
6. Set of external control parameters {Contr}.
7. Set which represents the age structure of population on an interval of time [0, T] ({Age[0, T]}). If the interval of time is not indicated obviously, we will write {Age}.
8. Set of initial conditions {Init}
9. Set which represents the structure of the system {StSys}, the structure of processes {StProc} and the structure of individuals {StInd}. These set of objects can be entered, if it is known as such objects are arranged. But it is possible only to assume that such structures indeed exist (even if nothing is known about these structures).
10. Additional requirements on the components (desirable) – additional to obligatory limitations $\{\Omega\}$ and $\{\partial\Omega\}$. We will designate them as {Aux}.
11. Descriptions rules for decision-making. We will designate those as {Decis}. If it will be necessary it is possible to split them on separate components.
12. Set of non-definiteness (uncertainties) in the system {NonDef}. This set also can be split on the components.

3.3 Description of SD problem

We will describe now formally, what does it mean SD concept.

Definition of the SD problem. To find the objects from {Init}, {St = {StSys} ® {StProc} ® {StInd}}, {Contr}, {Decis}, such, that as a result the trajectory of evolution of the system turns out tr $\in$ {Traj}, that is executed <tr, Cr>t $\in$ {SDCrit} ® {Aux} , where <tr, Cr>t means the calculation of value of the SD criterion in a moment t on a trajectory tr, thus the results of calculation must at every instant of time belong to {SDCrit} and to {Aux}. (The symbol ® means the belonging of parameters to all remarked sets).

3.4 Parameters and structures in SD (illustrations)

We will show the sense of Definition on the simple illustrations at geometrical pictures. We will do a few remarks before.

Remark 1. To the twelve points indicated above it is possible to add another one – set of models {Models}, if we use the modeling.

Remark 2. Under consideration of different systems it is possible in such case to accept category approach and try to select the category of the systems with sustainable development CatSD.

Remark 3. Taking into account the possible multi-valuedness of trajectories of the system (which can arise up from different reasons, including existing of social component in SNET (socio-natural-economical-technical systems)). Therefore in place of one trajectory tr it is possible to enter formulations with the bunch of trajectories Ptr.

Remark 4. It is possible also to take into account the existence of fluctuations and other uncertainties (by the way, this is essential for estimation of risks). Then it is possible to take into account vagueness in objects, considering some sets from 1-13 under some uncertainty conditions

{SDCrit}(NonDef), {Aux}(Nondef), {St}(NonDef).

Taking into account the structure of Definition for SD problem it is possible to proceed further and extend it to more detail determination.

Consideration of presence of many different generations (for simplicity below we speak about two generations) may be essential for global SD problem. For example, two generations may have different criteria of SD, then

{SDCrit} = {SDCrit}(Generation 1) ® {SDCritGeneration 2}.

The limitations on the managements can be different for different generations

{RCtrl} = {RCtrl}(Generation 1) ® {RCtrl}(Generation 2).

It can be in principle, that

{SDCrit} = {SDCrit} (Generation 1) ® {MSDCrit} (Generation 2),

where {MSDCrit}(Generation 2) is the set of possible criteria of SD for second generation. We cannot know exactly {MSDCrit}(Generation 2) by virtue of that it relies on future technologies, and actually depends on forthcoming knowledge {Knowl}(Generation 2),

about which we can only build assumptions (we consider that main volume of current knowledge of the given generation {Knowl}(Generation 1) is known – or, for example, this volume of knowledge already is realized in technological knowledge.

3.5 Examples

We will pose some examples for illustration.

Example 1. We can at first approximation pose the set {SDCrit} as the set, where some model indexes are accepted for SD by experts. That is, indexes ind, which belong to the set {Ind} of indexes belongs to the acceptable by experts picture of SD – to the set {IndSD}.

Then a process will be with SD, if ind $\in$ {Ind}, and ind $\in$ {IndSD} for any moment of time t.
Thus, of course, many details of processes and properties of the systems hadn't been taken into account. We will remark some interesting works devoted to the search of the SD indexes.
By the way, in works by D.Forrester knowledge does not enter in the collection of basic variables obviously.
Example 2. (The Chichilniska papers – see [19]). In her papers, as far as it is possible to judge, the indexes are formed from the economic considerations only.
Example 3. (The D.M. Rand papers). {St} changes during time, and it is possible to formulate mathematically strictly criteria set {SDCrit}.
Example 4. The cases, when {SDCrit} can be formed by the Lyapunov's function.
Example 5. Evolutionary economy. It is possible, in principle, to make comparison of the SD research in the frame of such formalization.
Review and comparison of the mathematical raising was very useful, and in the future we hope also to present their results as table. Here we will make only some illustrative examples.
Example 6. (Local SD). More simple case of SD exists, if a situation does not change substantially at time. The simple models (as a rule, this model devoted to one of «pillars» - economical, social or natural) of the system thus can be used without consideration of change of generations.
Also it is clear, that it is possible to write down the SD criteria of different kinds (for example, speed on the trajectories, stocked energies for the management and others).
In such case (local SD) it reminds the tasks of optimal control on the base of mathematical raising (optimization with limitations).
By the way, the guided Markov's chains from the given point of view, and the Markov's chains with anticipation or with vagueness – semi-Markov's chains are interesting.
It is possible to do the same investigations on SD for Lorenz's system (with chaotic trajectories). It will be the manifestations of the SD in case of chaotic systems.
It is possible similarly apply proposed concept of SD to the stochastic differential equations or partial differential equations in relation with synergetic and dissipative structures theory.

4 Indexes for sustainable development

4.1 Some ideas for sustainability indexes building

Considerations from sections 2 – 3 also can help in solving other important problem in sustainable development – namely in searching indexes of sustainability. Recently many such indexes had been proposed for different scales, different problems and by different organizations and institutions (UN approach, World Bank indexes, state government indexes). But the general problem of building background for indexes is open. Partially this is because of instant character of indexes.

According the sustainable development analysis there are some hierarchy of proposed indexes depending on the chosen detalization of the processes in the system. The simplest is the case of little number of essential parameters in the system. For example the parameters may belong to some space X (frequently $X = R^N$, N – not very large integer number, usually less then 100). Then in simple case we can consider fixed restrictions for system states in space X. That is $\vec{s}(t) \in \Omega, \Omega \subset X, \vec{s}(t) \in X$, where $\vec{s}(t)$ - state vector of the system for which sustainable development should be considered. Note that not only the system state $\vec{s}(t)$ at a given moment t is important, but also the evolution of the system should be accounted because the system trajectory follows to restriction $\partial\Omega$ (where $\partial\Omega$ is the boundary of the accepted domain Ω). Let us introduce the value

$$J(t) = J(\Delta(\vec{s}(\tau), \tau \in [t,T)); \Omega; \partial\Omega; X; T) \qquad (1)$$

as the integral index (or vector of indexes) of sustainability of time t. In formula (1) $\Delta(\vec{s}(\tau), \tau \in [t,T))$ is some integral evaluation of the distance of trajectory from the restrictions $\partial\Omega$ on some time interval [t, T). Implicitly in this case we suppose that the trajectories of the system $\vec{s}(t)$ can be calculated by some models. Intrinsically evaluation of $\Delta(s(t))$ may also include using the derivatives of indexes with time derivatives and other operators. That is such case calculation of sustainability indexes corresponds to the weak anticipation. Note then in special case of $T = t$ we receive the case of many recent sustainability indexes.

The case of more complex systems require more developed definition of indexes (just for simplification of fixed restrictions) because of high dimensions of real systems. Remark that the case of varying with time restrictions may be considered by calculating Δ with non-constant $\partial\Omega(t)$.

The second problem following from high dimensions of considered system is more involved. Usually in case of sustainability investigations only a small number of measurements are known (usually from some space R^{N_1}). In this case we can subdivide all the parameters N on two parts - N_1 measurable parameters (or visible parameters) and $N_2 = N - N_1$ internal (invisible) parameters. In such case the formula (1) should be modified to the next formula

$$J(t) = J(\Delta_1(\vec{s}(\tau), \tau \in [t,T)); \Omega_1; \partial\Omega_1; \Delta_2(\vec{s}(\tau), \tau \in [t,T)); \Omega_2; \partial\Omega_2; X; T) \qquad (2)$$

where $\Delta_1(\vec{s}(\tau), \tau \in [t,T))$ is evaluation of distance from restrictions for measurable parameters and $\Delta_2(\vec{s}(\tau), \tau \in [t,T))$ is evaluation for distance from restrictions for internal parameters.

Thus the development of such indexes (evaluation of sustainability J(t)) in the case of weak anticipation are known but may be technically complicated especially in searching adequate for real data indexes. Such way for indexes calculations is most suitable for case of 'local' management.

4.2 Anticipatory aspects of sustainability indexes

Much more interesting is the general case of sustainable development when strong anticipation should be accounted. The formal constructions of sustainability indexes above can easy formally modified. But the sense of such constructions and derived results may change principally because of principal difference between weak and strong anticipation. Remark that according ideas on weak and strong anticipation [22-24] in case of strong anticipation the system creates oneself. So in our case we cannot predict the trajectories and the restrictions depend on the evolution of considered systems. Thus in such case we can speak on the 'anticipatory' restrictions on accepted domain of space for system variables. So we cannot calculate the distance from the future unknown restrictions. This follows to the needs of models with anticipation, their multy-valued solutions and multy-valued restrictions. Each of the branches of the solutions will have different presumable variety of restrictions. Also the average risk for different values of management should be considered as intrinsic part of sustainability indexes evolutions. In such case the definition of index (indexes) should be changed. For simplest case it can be considered as

$$\widetilde{J}(t) = J(\widetilde{\Delta}\{\vec{s}(\tau)\}, \{\widetilde{\Omega}(\tau)\}, \{\partial\widetilde{\Omega}(\tau)\}, \tau \in [t,T)) \qquad (3)$$

where $\{\vec{s}(t)\}$ - presumable set of system trajectories, $(\{\widetilde{\Omega}(\tau)\}, \{\partial\widetilde{\Omega}(\tau)\}, \tau \in [t,T))$ - presumable sets of restrictions, $\widetilde{\Delta}$ - distance between sets of presumable trajectories and restrictions. Note that in the case of the system with discrete time steps the sets $(\{\Omega(\tau)\}, \tau \in [t,T))$ have for example the form

$$\{\widetilde{\Omega}(\tau)\} = \{\Omega(t), \Omega(t+1), \Omega(t+2), ..., \Omega(t+T)\}$$

which is more suitable for applications of the theory of strongly anticipated systems from [22-24].

That is in given subsection we have posed sustainability index consideration. Further development of the theory and searching the adequate practical indexes will depend on using different mathematical models of the system. So in the next sections we very briefly describe some facts about our models which are useful for considering sustainable development aspects.

5. Background for social systems modeling

Associative memory approach to large socio-technical systems had been proposed earlier: [25-27]. Initial structures in description are 'patterns'. The 'pattern' is the collection of elements and bonds between them at any moment of time [25-28]. Such description (patterns) is useful as for environment as for the mental structures of individuals (or agents in the models). Such 'geometrical' description may be transformed in pure 'logical' or sometimes 'linguistic' description.

5.1 Some facts on social systems

Firstly some global structures (for example formations or civilizations) in complex system dynamic exist. The socio-technical system exists in the frame of such structures. Secondly, alternation in elements state frequently is determined by the influence of environment. This can be described by some mean field approach.
There are many interrelations between the elements of complex systems (and not only in social but also in natural systems).
Examples of the properties:
There are many sub-processes in such system – communicational, political, social, and cultural and so on.
The system can go from one global structure to another by two ways: evolutionary or by revolution.
Revolution can be described by fast rupture of bonds and may be unpredictable.
Evolutionary way is long and demands patience.
Yet on such global level there are phenomena of life- cycle type.
For example, the change of social formation may be considered as the change of "patterns" in such models.
Branch of industry may be considered as union of producers, consumers and mediators.
These relations in industry have the same properties as the elements of global model:
The bonds are origin evolutionary; all structure of industry branch is rather stable.
Mentality is other important components in such systems: Internal representation of external world and mental properties and real pattern of the world and 'known mental representation' are important.
Simplest example of such type models is Hopfield type model with 'Landscape' of potential function [27, 28].

5.2 Society as the networks of individuals and other components

The society may be represented in such case as the collection of agents and bonds (some illustrative pictures see for example at [25-27]. Remark that the internal structure of agents also may be simply represented at such pictures. Such representations are useful for understanding of SD problem of society and role government in such processes. Also the SD and government also receive some theoretical background. The main peculiarities are that the problems of government of SD had been evident as the problems of changing the mental patterns of individuals on such issues. Simple examples of such kind also may be proposed.

5.3 Anticipation and possible consequences in models

Anticipatory property for social systems and scenarios had been introduced (R.Rosen, D.Dubois).
Remember from section 2 that one of very interesting for understanding the social systems property is anticipating [22-24].

Weak anticipation – when the system has the model for forecast the future behavior.
Strong anticipation – when the future state of the system is taken into account for evaluating the transition at any given moment of time.

The main essential new property in such case is the possibility of multi-valued solution (that is many values of solution for some moments of time exist for single initial conditions). This may be interpreted as the possibility of many scenarios of development for real social systems.

The second key issue is connected to property that the real social system has single realization of historical way (trajectory). So the social system as the whole makes the choice of the own trajectory at any moment of time.

Local SD processes usually are the processes with weak anticipation.
Global SD processes are strongly anticipative.

Scenarios and decisions have background in multi-valued solutions and single trajectory choice [27].

6. SD Modeling and interpretation

Of course proposed ideas require a further implementation in theory and practice. Sometimes its may be realized in the case of simple systems and processes with particular type of models. In such case we can propose to use existing more or less simple models and try to apply the definitions above for the better understanding of sustainability features. One of useful class of presumable models may be already existing economical models of growth (first of all the models and issues from [6, 15, 18, 19]).
Also remark that proposed ideas may be tested just in the case of considering ordinary differential equations with restrictions as the object of sustainability considering.
But in the case of global problem of sustainable development the situation is much more difficult. In such case general models should be proposed for quantitative considerations and foresees. Different types of models should be developed for different aspects of whole society: ecological, economical, social, political etc with the goal to build the general integrative model. It is very difficult research problem. But existing models in binding with proposed approach may help in qualitative understanding of sustainable development phenomena. Special considerations of knowledge on sustainable development through involving mental properties into consideration may be useful. Remark that the models remembering in the section 5 (some details see at [25, 26]) may be useful for all aspects of society properties. But the most interesting is the possibility to account for the properties of society members, namely the mental properties. So at the next section we shortly remark some such possibilities.

7. Mentality and Government

7.1 Mentality aspects

All such issues are useful for considering all kinds of sustainable development. The problem of sustainable development in our approach looks like the problems of the evolution of the system in the terms of attractors, and the transitions from one attractor to other [27].
For understanding and managing of sustainable development the use of the concept of 'landscape' 3 may be helpful. In such a case, the state of the system evolves on the 'landscape' to the nearest local minimum of the functional which corresponds to the 'landscape' (the pictures will be proposed at presentation).
Sustainable and non-sustainable ways correspond to different minimum if the bonds between elements are constant and internal patterns of elements are fixed.
But the change of norms, beliefs, ethical norms and concepts follows to the deformation of 'landscape'. So in this case the change of norms may push the system from one minimum to other without increasing the 'external energy' (the functional of the system). Also, the changes in mentality can create the new minimums in the system (creating the sustainable way).

7.2 Sustainable development of knowledge and of education

The investigations on sustainable development have been related mainly with the problems on natural resources and energy.
But only now, it has been recognized that very important (or just most important) other aspect of society life became – namely infrastructure, skills and knowledge. One of the examples is government systems and applications. In such context the list of posing new problems and challenges are: the development of government; the government use; transfer of skills and stiles of life between generations; spreading of using of government in society; reproduction of consumer and apologists of government bearer (that is researchers, teachers, students) etc.

8. Conclusions

In this paper we describe an approach to considering the social systems and decision–making process in them which can be useful for studying the sustainable development.
Some frames for formalizing sustainable development processes, including building sustainability indexes are proposed.
The approach is based on the considering the models of society, including relatively new models which have the property of associative memory and which allow to incorporate the mental peculiarity of involved individuals.
Remark that considering of the property of strong anticipation leads to the existence of multi-valued solutions (which correspond to the uncertainty in the future system states in global sustainability problem). Even qualitative consideration of such properties

allows understanding of some aspects of decision–making processes, development of government and its impact on the society.
Of course here we have proposed only the first steps to sustainable development formalization and anticipation accounting. Proposed concepts require further development and implementation in real problems. It may require a hard and difficult work. But we hope that these approaches may be useful for further development of sustainability understanding.

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