THE CONCEPTUAL-THEORETICAL FRAMEWORK FOR THE APPLICATION OF BIOPHYSICAL AND BIOGEOCHIMICAL INDICES OF AGRICULTURAL ADAPTIVE-LANDSCAPE SYSTEMS

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Abstract

The imperative of biologization and agroecosystems greening approach requires adaptation to landscape of agricultural systems. The concept of landscape adaptation come to substitute the concept of the regional systems and involves the principle of adaptation to concrete landscape conditions and systemic approach to soil-plant interactions. In this sense the landscape adaptation of agroecosystems involves taking into account the adaptation capacity of agricultural crops and their adaptive potential to the landscape. Adaptive capacity does not require only crops features to capitalize the functional reserves of the soil, as well their ability to model the soil in accordance with their needs. Adaptive potential of the landscape in this case, involves the ability of its component firstly to model the soil by plants. Through this prism of ideas, the focus is displaced to landscape adaptation from soil modeling through works for crop needs to self-modeling in the phase of crop development. This leads to renaturation of functioning process of soil ecosystem and the characteristics and dynamics of soil regimes. In this sense the evaluation of degree of correspondence of the agroecosystems to landscape conditions and monitoring of adaptive landscape agroecosystems is recommended the application of agrophysics indices materialized in the physical condition of soils and biogeochemical indices materialized in the components and biogeochemical cycling volume of substances.

Key words: agricultural systems, landscape adaptation, agroecosystem.

The biologization and greening of agroecosystems implies adaptive landscape approach of the agricultural systems. The concept of landscape adaptation meant the substitution of the regional agricultural systems concept by adaptation principle to the concrete landscape conditions and a systemic approach of soil plant interactions. In this sense landscape adaptation of agroecosystems includes the consideration of the adaptation capacity of agricultural crops and the adaptive potential of the landscape. Adaptation capacity implies only the characteristic of crop to harness the functional reserves of the soil, but also their ability of modeling the soil according to their needs. The adaptive potential of the landscape in this case implies the ability of its parts, firstly the soil shaped by the plants. This is stated by the biophysical and biogeochemical character of landscape adaptation materialized in the stages of formation of the soil biorutinar systems.

MATERIAL AND METHOD

The biorutinar system represents an integrated system formed as results of development of relations between living organism and vital environment. The biorutinar system is synonymous with ecosystem. The term was first used by Vernadsky (1944). According to the same author cited one of the main features of the living matter (substance) is the progressive trend to optimize is vital environment in the respective landscape condition (Vernadsky, 1944).

Through this premise of ideas biorutinar soil system was established as a natural optimal mechanism for ensuring the vital activity of organism (plants) photosynthesis. Establishment of soil biorutinar system involving a series of stages in the geological time scale (*table 1*).

The processes of constitution of the soil biorutinar system, their hierarchy and their interaction are shown in *figures 1, 2, 3* and *table 2* (Jigau, 2011a,b; Jigau et all., 2012).

Through this prism the concept of soil biorutinar system, the adaptive landscape adaptation involves ensuring compliance with composition and volume of substances of biogeochemical cycle in the soil biophysical framework. Under current agricultural systems assciated with physical degradation of soils that compliance is not ensured.

RESULTS AND DISCUSSIONS

Assessing the role of agricultural crops in exploiting the adaptive potential of soil include

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considering the direct impact, these may have on soil (soil modeling in accordance with biological demands of crops) and indirect impact (decomposition and transformation processes of organic matter in the soil). In this sense is established the quantity and composition of organic debris as well root secretions which have a decisive role in defining the species, number and diversity of microorganism involved in the decomposition and transformation processes of organic debris and intensity, and their meaning. According to the research balance weight and organic debris circuit and organic substances in the establishment of soil bulk density values constitutes 88.7 per cent, porosity is 97.8 percent and aggregate stability constitutes 98.5 per cent (Prudnikova, 2005).

At the same time the biophysical characteristics have a decisive impact on agrocoenotic metabolism, causing rate and dynamics of biogeochemical cycles, soil biota activity, the processes and transformation of substance and energy.

The ecosystem role of the biophysical characteristics is to ensure the conditions for activity of microorganism participating in the processes transfer of substances and energy, and transformation of organic substances.

Table 1

Stages for setting up the biorutinar system of the soil

Stage/substage	Content
1. Abiotic physic-chemical	Physical weathering processes. The loosening of compact rocks. Formation of porosity, air capacity, air permeability, water permeability, water capacity. Decomposition processes and mineral neo synthesis. Constitution of ionic-colloidal complex. Mobilizing the biofile elements.
2. Biophysical-biochemical 2.1 Biophysical 2.2 Biochemical	Evolution of physical processes. Constitution of elements of hydric, aeration and thermal regimes. The establishment and development of the first living organisms (bacteria, blue-green algae). Constitution of bacterial and algal associations. Initiation of biochemical processes. Processes of evolution of the physical framework. The evolution of biota: [bacteria]+ [blue-green algae]+ [diatomaceous algae] → [musgrooms]+ [lichens]+ [moss]. Initiating and developing of biological transformation processes of mineral components. The early modeling of biological processes of mineral substrate.
3. Early pedogenesis	The absence of clear pedogenetic features. Not significant proportions of the biological cycle. Significant proportions of abiotic processes. Weak links between processes arising in the biologic and abiotic cycle. Expression of weak biogeochemical cycle.
4. Development of pedogenesis 4.1 Accelerated development 4.2 Attenuated development	Extending biological cycle. Establishment and starting the pedogenetic mesoprocesses and architectural organization of soil. The vertical differentiation of the features and characteristics of aggregate level, horizon and profile. Establishment of biogeochemical cycle. Reduce the extending intensity of the biogeochemical cycle. Development of macro processes in establishing soil profile. Compliance of biogeochemical cycle to biophysical condition of substrate.
5. Balanced pedogenesis	Balanced processes between the solid, liquid and gaseous components of soil. Process stability of functioning soil biorutinar system except those seasonal and dynamic.

Hydrostable aggregates determined 81.3 per cent of the bacillus population, 70.5 per cent use the mineral nitrogen, and those that break down the cellulose. Porosity has the role in the development of bacillus (92.6 per cent) and fungus (77.6 per cent). The apparent density 80.7 per cent is accounted to ensure microbial activity that use the mineral nitrogen, 52.6 per cent for microorganism that break down the cellulose and 55.8 per cent bacilli (Prudnikova, 2005).

The interaction of biophysical characteristics and biogeochemical circuits is ensured by the organic substance of the soil. In this regard it is established that the plastic stability of the crops is directly dependent on the content of organic matter (R=0.99). Direct proportional to the organic matter content is the aggregates content 0.01-0.005 mm (R=0.85) (Prudnikova, 2005).

The research mentioned involve conclusion that to ensure maximum efficiency interaction of abiotic and biotic components, it is possible only by increasing permanently flow of organic matter in soil, reduction of mechanical pressure, and technogenic impact on soil. Within such approaches the starting point will be the concept of “soil ecosystem” where the soil is self-regulating system.

In natural conditions the majority of substances flows and energy are determined by the activity of microorganisms. In the situation when functionality of soil ecosystem involves an external factor occurs “atrophy” mechanism responsible for the process.

In this sense, research showed the nitrogen inputs in agricultural ecosystems through fertilizer management process cause reduction intensity of nitrogen fixation by symbiotic microorganisms. The same effect is found in the case of non-symbiotic microorganisms (blue-green algae).

Vinokurov (2005) names this process thermodynamic pressing and considers this is one of the main causes, while reducing soil diversity biota, reducing the intensity of biogeochemical processes and bio-productivity, and agroecosystem degradation and desertification.

This situation requires new approaches based on new concepts of agricultural development. The number of such approach is the concept of biophysical agriculture called to stop the land degradation, to reduce expenses connected to production and remove other negative consequences of modern agriculture.

Table 2

Hierarchical levels of structural organization of biorutinar system in the soil

Structural level	Structural elements	Particle dimensions, mm	Specific processes	Specific changes and other features	Soil proprities determined by level
Atomar Ionic-molecular	Ion, stable radicals, mineral matrix (oxides, hydroxides, salts, carbonates, gypsum, aluminosilicate) Organic matrix	$10^{-7} – 10^{-4}$	Biochemic, biophysic (organic-mineral) reaction	Formation of new chemical compounds and minerals. Formation of organic substances	Physic-chemic, physic, permeability, pH, filtration, cation exchange capacity, mobility degree of substances, water
Plasma-colloid Elementar particle	Mineral matrix, humic-mineral, ferment-mineral, microorganism mineral, ultra mineral aggregates	$10^{-4}– 10^{-3}$	Surface reaction (sorption and desorption) Participation in setting the physic-chemical equilibria	Molecules and ion exchange between solid and fluid phases. Influence the ion dynamics and their movements between soil and plant	Hydrophysic, thermophysic
Microaggregates	Organic-mineral matrix	10^{-3}– 0,5	Water retention	Storage, preservation and circulation of water in the soil, between soil and plant	Thermophysic, mobility degree and water accesibility
Agreggates	Microagregates, cutaneous, manganese	0,5 – 2,0	Water retention in the aggregates concomitant with the existence of air between aggregates. Ensure the permeability for water and air. Combining microorganism activity aerobic and anaerobic (in aggregates)	Schimb de apă şi gaze între agregatele de sol şi golurile existente între agregate. Absorbţie de apă (cu nutrienţi) de către rădăcinile plantelor din agregatele de sol. Forţe capilare şi forţe gravitaţionale.	Permeabilitatea pentru apă şi aer, conductivitatea hidraulică. Migrarea substanţelor. Porozitatea de aeraţie.
Horizon	Morphon, neoformations, inclusions	-	Reversible and irreversible reactions, segregation processes. Accumulation of humus, nutrients, water, air, salts through additions, changes, migration. Diffusion processes and local transport.	Exchange of various compounds between horizons, formation of features and specific morphological proprities, including neoformations	Morphological features, geochemical barriers
Profile	Horizons	-	Translocation and accumulation in soil (predominantly vertical), formation of humus reserves, nutrients, water; dynamics of water content, nutrients, salts of temperatures (regimes)	Substances exchange; energy and information between soil and envrionment; biogeochemical cycles of the elements, cycles of water (moistening and drying); flows of solutions washing and accumulation	Stability of ecosystem, agro-ecosystems

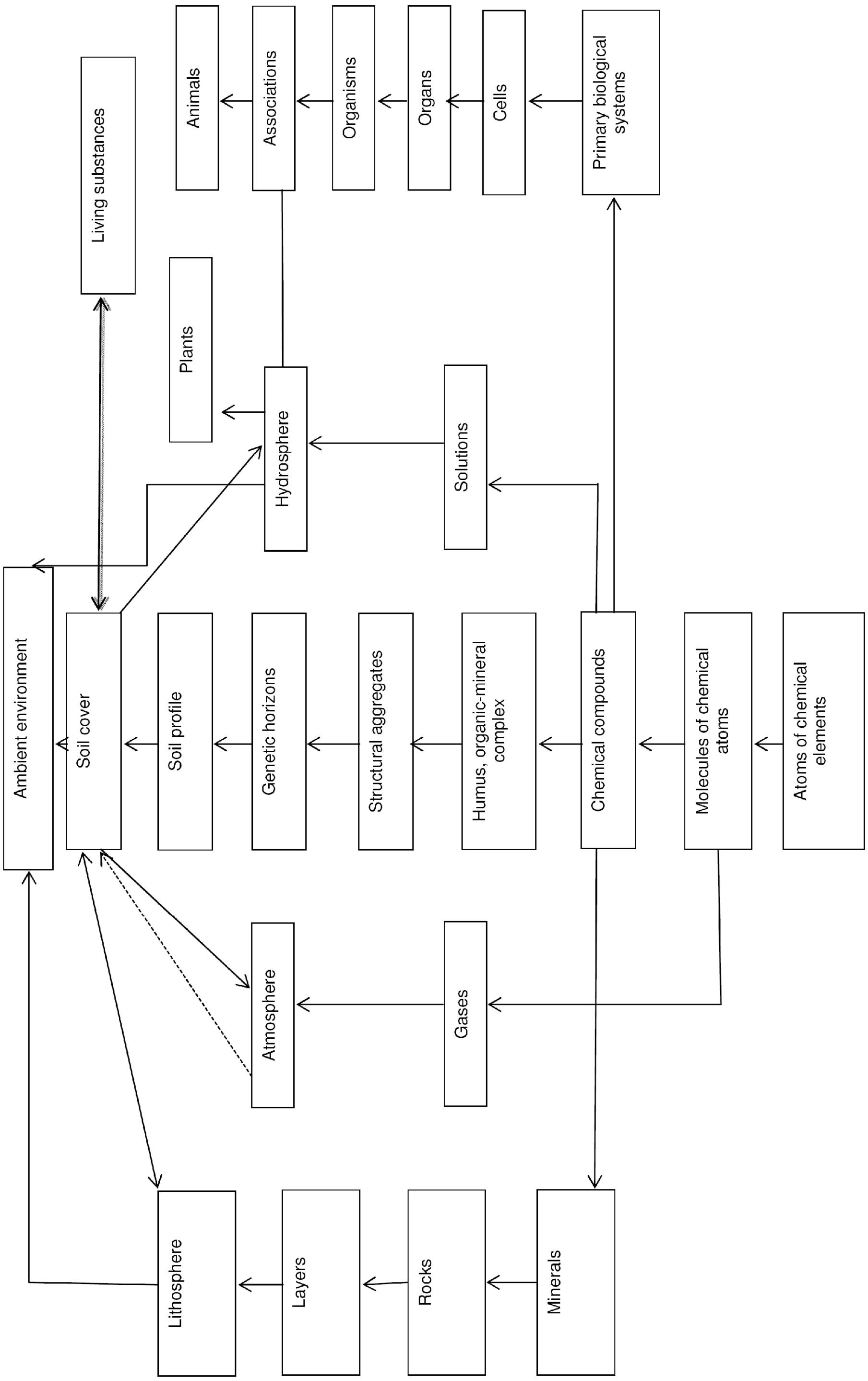

Figure 1 **Integrated scheme of formation, evolution and functioning of the soil biorutinar syste**

Agriculture biophysics is a controlled process of crop cultivation and increase soil fertility in some concrete landscape condition (Agricultural landscape) based on soil-plant interaction, fauna, and microorganisms. Such model of agriculture means not only increasing crop yields but also the enlarged reproduction of soil fertility based on eco-genetic principles.

This model involves creating of optimal conditions for the interaction of pedogenetic, physic, geochemical and biological processes in soils. This objective can be achieved through implementation of conservative agricultural technologies adapted to the landscape conditions, capable of achieving reduction to a minimum the physical degradation processes and creating optimal conditions for plant growth and soil biota components associated with them.

This will start a new era of self-regulation of pedogenetic processes able to ensure expanded reproduction of soil and their fertility.

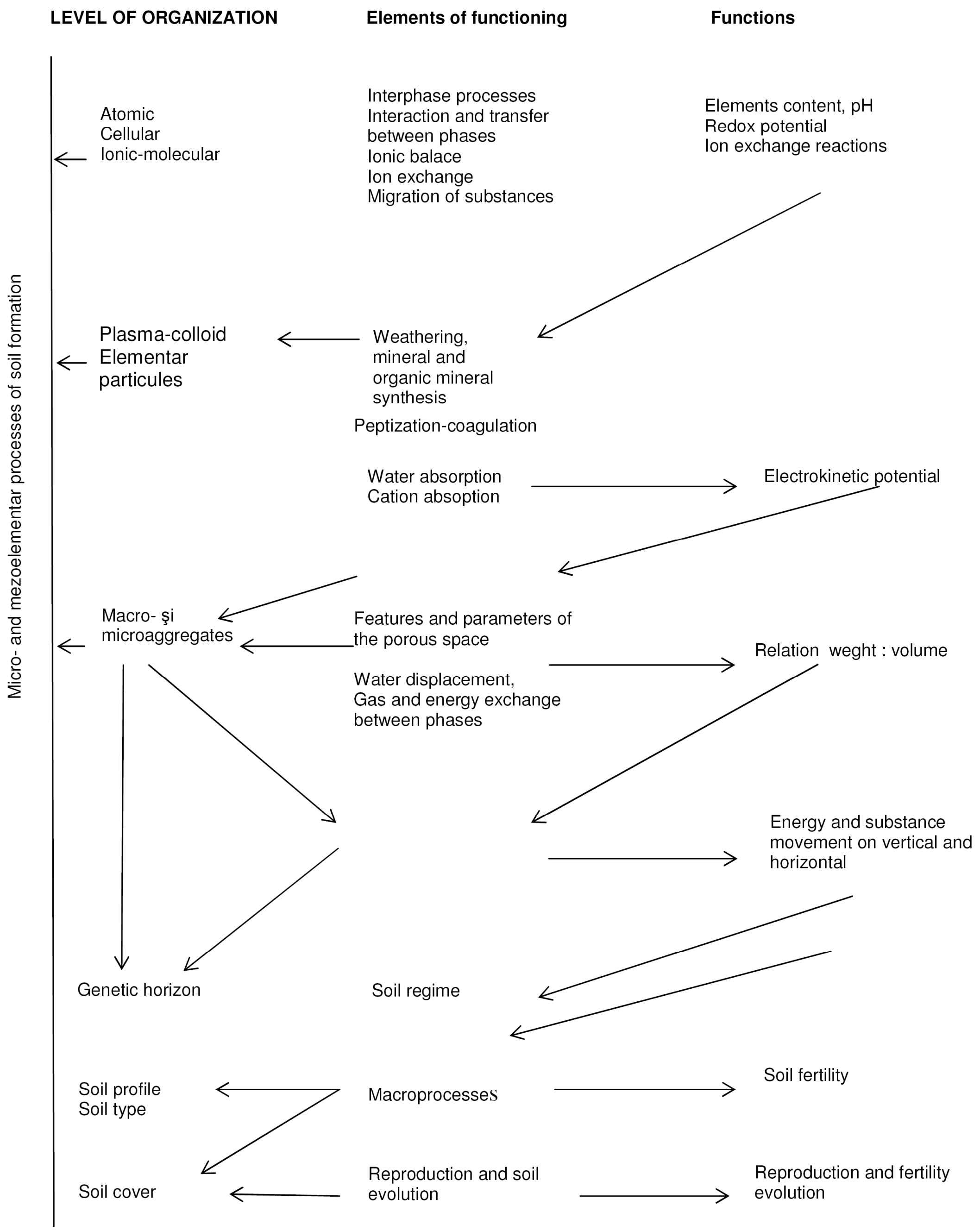

Figure 2 **Hierarchy of formation processes of soil biorutinar system**

CONCLUSIONS

Adaptive potential of the landscape involves the ability of its component to model the soil by plants. The concept of landscape adaptation come to substitute the concept of the regional systems and involves the principle of adaptation to concrete landscape conditions and systemic approach to soil-plant interactions. In this sense landscape adaptation of agroecosystems involves taking into account the adaptation capacity of agricultural crops and their adaptive potential to the landscape.

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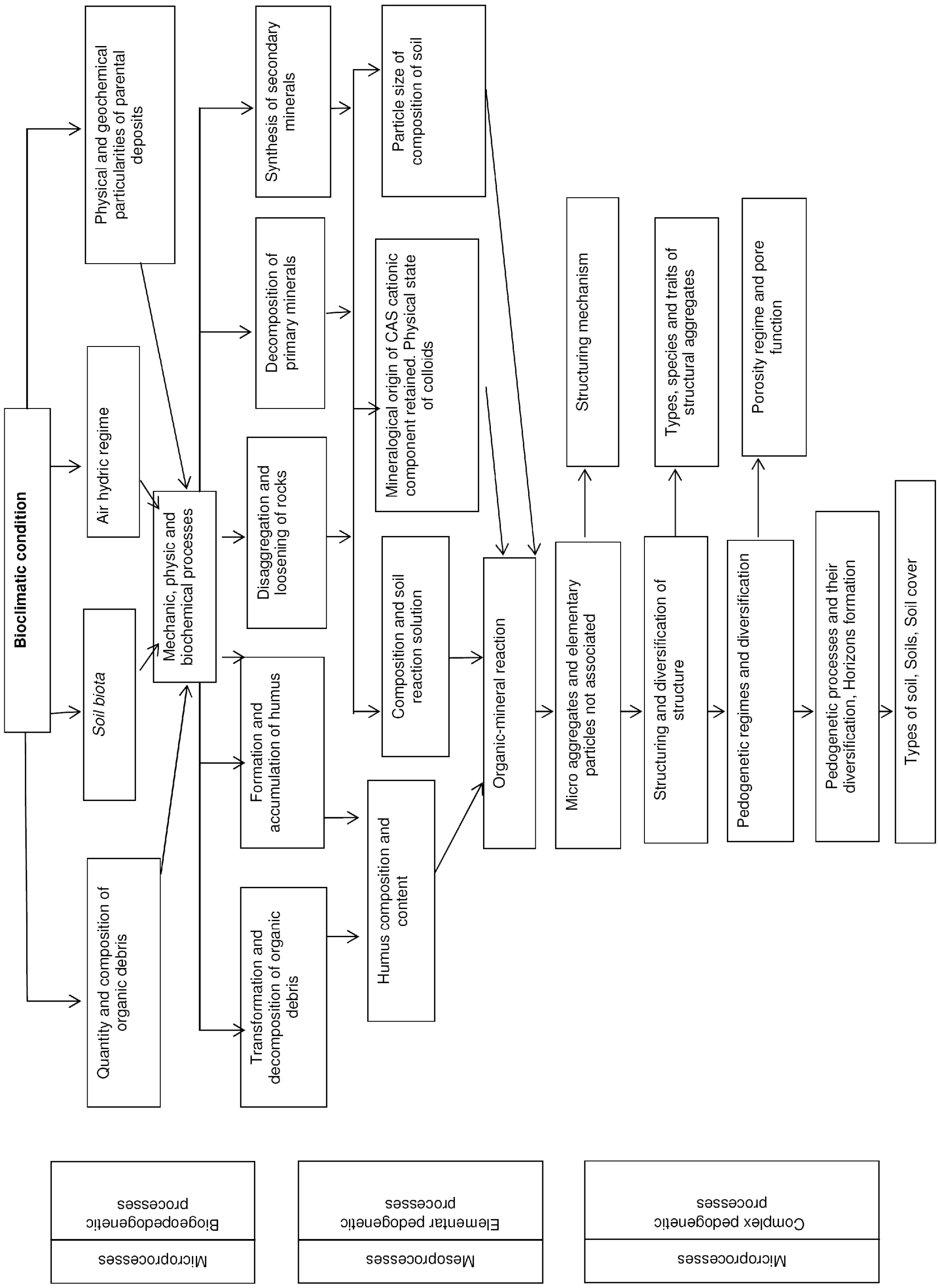

Figure 3 **Hierarchy and interaction of elementary processes of soil**

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