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IT-based soil quality evaluation for agroecologically smart land-use planning in RF conditions

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Activated in the first decades of XXI century global climate, economy and farming changes sharply actualized novel IT-based approaches in soil quality evaluation to address modern agricultural issues with agroecologically smart land-use planning. Despite global projected climate changes will affect a general decline of crop yields (IPCC 2014), RF boreal and subboreal regions will benefit from predicted and already particularly verified temperature warming and increased precipitation (Valentini, Vasenev, 2015) due to essential increasing of growing season length and mild climate conditions favorable for most prospective crops and best available agrotechnologies.
However, the essential spatial heterogeneity is mutual feature for most natural and man-changed soils at the Central European region of Russia which is one of the biggest «food baskets» in RF. In these conditions potentially favorable climate circumstances will increase not only soil fertility and workability features but also their dynamics and spatial variability that determine crucial issues of IT-based soil quality evaluation systems development and agroecologically smart farming planning.
Developed and verified within the LAMP project (RF Governmental projects #11.G34.31.0079 and #14.120.14.4266) regionally adapted DSS (ACORD-R – RF #2012612944) gives effective informational and methodological support for smart farming agroecological optimization in global climate and farming changes challenges.
Information basis for agroecologically smart land-use planning consists of crops and agrotechnologies requirements, regional and local systems of agroecological zoning, local landscape and soil cover patterns, land quality and degradation risk assessments, current and previous farming practices results, agroclimatic predictions and production agroecological models, environmental limitations and planned profitability, fertilizing efficiency DSS ACORD-R.
Smart land-use practice refers to sustainable balance among soil 7 principal types of agroecological functions: (a) Agroclimatic ones of plant supply with photosynthetic active radiation, effective heat and available moisture; (b) Agrochemical functions of crop supply with available macro- and micro-nutrients; (c) Agrophysical ones of favorable condition support for farming effective workability and trafficability; (d) Hydrophysical functions of plant seasonal supply with available moisture and soil air exchange; (e) Phyto-sanitary functions of favorable condition support for crop minimum damage by pathogens, pests and weeds; (f) Ecogeochemical ones of soil resistance to contamination; (g) Ecopedomorphogenetic functions of plant and farming support with soil agroecological quasi-homogeneity in space and time.
The IT-based soil evaluation algorithm includes 4 particular ones: (i) the principal agroecological parameters assessment by their modelling or adapted to concrete soil type logistic equation; (ii) agroecological function assessment as corrected harmonic mean from its parameters assessment values; (iii) homogeneous land unit assessment as combination of its functions values; (iv) heterogeneous land unit assessment as weighted average value corrected by soil cover patterns contrast and boundary complexity – with their results visualization.
The principal limitations for sustainable land use practices are usually determined by the level of photosynthetic active radiation or soil available water deficit, soil fertility and agrotechnological parameters, risks of soil degradation processes development, crop physiological stress, production or environmental contamination. The agriculture intensification often leads to the raised issue of greenhouse gases, including 2 (as a result of soil organic carbon mineralization), CH4 (animal production) and N2O (mineral fertilizing), to changes of the profitability and decrease in soil potential of the atmospheric carbon sequestration. The consequence of agricultural land degradation due to non-rational land-use can be disturbance of soil organic matter fluxes and traditional transformation processes. So, agroecosystems are very sensitive to global changes and their IT-based timely adaptation is the necessary condition for their sustainable functioning and ecosystem services support, including an inhabitancy, water and foodstuffs stocks.