The development of ecosystem spatial-temporal thermodynamics theory and methods of thermodynamic variables measurement

Development of the self-organization theory for complex biological, social and economic systems is focused on the solution of the most urgent problems for life support of humans, including providing with food, water and other vital resources, forecasting and predicting the social and economic breakdowns in global and regional scales, development of controllability, etc. Solution of these tasks the scientific community links with developing the theory based on ideas of not extensive thermodynamics, the theory of information, the theory of nonlinear dissipative dynamic systems and synergetics. The solution of such problems requires new theoretical and experimental studies in all natural and social areas. The present project is aimed to develop the theory and methods for experimental measurements of the major strategic parameters on the ecosystem and landscape levels. As a theoretical basis for representations the non-extensive thermodynamics, related statistics (rang distributions), exergies, criteria of the nonequilibrium state, the self-organized criticality, models of nonlinear dynamics of dissipative systems and their generalizations in synergetrics will be used. This need to develop the corresponding methods that are applicable for the measurements of real systems. The consequences following from modern theoretical representations will be checked on the basis of direct measurements of fluctuations of sensible heat, moisture and carbon fluxes in forest and mire ecosystems using an eddy covariance equipment on flux towers. Temporal and spatial fluctuations of variables will be investigated on the basis of multispectral and hiperspectral remote sensing data obtained from satellites, eddy covariance flux measurements, and vegetation, soil and microclimate observation along transects. In the project the various models of a thermostatics will be verified, the models corresponding to reality and selected the relations that are not kept within a existing theoretical frameworks will be justified. During the study the methods reflecting temporal and spatial variation of the major thermodynamic variables e.g. exergies, heat fluxes, non-equilibrium, biological productivity and its dependence on external variables, methods for assessing a non-equilibrium state of ecosystems within a landscape and the direction of ecosystem evolution, selection of territories with potentially catastrophic (fast) transformations will be developed. As a result of the project the first systematic synthesis of many known empirical laws (for example the power law) will be obtained for different environmental components and various processes.

It will be proved as far as it is possible, the physical basis of their realization, it will be developed the general technology for displaying of spatial and temporal dynamics of ecosystem and landscape components.

This technology creates a basis for assessment of potential of social and economic development of any territory on the basis of multispectral remote sensing data. Within frameworks of the project of in one study and for one territory for the first time in the world will be considered all components with various physical nature of realization e.g. atmosphere, mesoclimate, relief, soil, vegetation and some groups of animals.