Assesment of sustainable development of region at natural risk

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Sustainability as one of the fundamental concepts in the study of the functioning of ecological systems arose as a result of strong anthropogenic impacts on natural systems and the need for quantitative assessments of such impacts. The works are connected with the quantification of the results of human impact and modelling transition areas for sustainable development are of great interests. On the other hand it is also important to assess "sustainability" of a region to the impacts of natural hazards.

The concept of "sustainability" for many years has been used successfully in mathematics. There is the classics determine "Lyapunov stability". However not everything is clear. If Lyapunov method shows that the system is resistant to perturbation, then this conclusion applies to the analyzed ecosystem. But in case when after a disturbance the system does not tend to the unperturbed trajectory and moves parallel according to the Lyapunov method the system is unstable to the action. But from the point of view of ecology sustainable development occurs when there is some defined corridor and development of the system passes through the inside of this corridor. Moreover, the ecological system can have multiple stable equilibria and if under a perturbation the system transitions from one stable position to another it is unstable in the Lyapunov sense but from the point of ecology despite the transition to another stable position, the system can be considered as stable.

Structure and assessment of regional sustainable development of mathematical model of social and economic components in view of environmental factors on the example of the Kirovsk - Apatity region was considered in the works (Svetlosanov, Mieslev, 1991; Svetlosanov, Kudin, Kulikov, 2008). Development of the Kirovsk – Apatity region is not unlimited. Limiting factors can be both the natural resource depletion and the environmental degradation below a certain level which are critical to the system. Upon reaching the certain (critical) limits the values of characteristics Kirovsk – Apatity region the system loses its stability.

In the case of the impact on the ecosystem the small perturbations like of the "white noise" was suggested the stability criterion (Svetlosanov, 1977; Svetlosanov, 1985) which includes the numeric coefficients defining the structure of ecosystem and the quantitative impact on the ecosystem. In certain cases to assess the sustainability of ecosystems is convenient to use a Monte Carlo method (Svetlosanov, 1990). Using a model the different scenarios and the estimations the probabilities of the transition system in an unstable region are calculated.