PRINCIPLES, THEORY, MODELS OF STABILITY AND CONTOLLABILITY OF EXPERIMENTAL CLOSED ECOSYSTEMS

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Biosphere in first approximation (taking into consideration the most general characteristics) can be characterized by the inflow of light energy, the presence of differentiated alive and inert matter and high degree of thermodynamic closedness. In the planetary scale the possibility of biocycles destruction due to the formation of biologically non-degradable matters (‘‘deadlocks’’) can be absolutely real, besides other mechanisms of biosphere degradation (toxicity, warming, ozone holes, etc.). The same problem exists in constructing artificial closed ecosystems, e.g. with the aim of life support for crew of spacecrafts, underwater and arctic settlements and the possible model prototype of noosphere. Manmade ecosystems with an essentially closed material cycle can be an efficient instrument for experimental modeling of biospheric processes, including the investigation of their tolerance towards human impact. It is well known that the life support systems intended for long-duration functioning should be based on biological material cycling. A high degree of closure of the material cycle in manmade ecosystems can be only attained by selecting the system components on a sound scientific basis and by achieving the necessary cycling rates of chemical elements and components and their conjugation. However, if the designers of the system ignore the knowledge of the closure mechanisms responsible for maintaining the long-duration and steady material cycling, there may be serious harmful consequences affecting the whole system. The example of such a failure is the attempt to keep “Biosphere-2” (USA) self-contained for a long period of time. Theory and two principles of natural closure of ecosystems: “ecological” (models and experiments) and “evolutionary” are presented in detail. Theory of optimum layout of closed ecosystems, composition control mechanisms and applications of these approaches to modeling essential properties of biosphere are given.