Preface

Complex systems, which defy investigation by the classical methods of mathematical physics, have been among key challenges of science in the recent century. Studies of complex systems primarily address understanding of life and its origin. This mystery prompted Ilya Prigozhine and Manfred Eigen, great scientists and Nobel laureates, to seek the specific properties of living systems that could let an insight into possible ways of how life may have begun. They are presumably self-organization and selection of the most efficient specimen. In fact, the very idea of self-organizing systems with natural selection originally comes from economics rather than from biology and belongs to Adam Smith and Malthus. Malthus's idea of overpopulation encouraged Darvin's discovery of the mechanism that drives the evolution of species.

Self-organization and selection are not specific of living matter but are common to many inorganic systems. They are found, for instance, in convection whirls in fluid and gas which one can observe in a river or in air flows around a hot chimney. However, of special interest are the living systems, from populations of cells in an organism (e.g., cancer cells) or pests in a forest to economic and social systems that appear and disappear in human cultures. In their evolution these systems can develop the states of stable or unstable equilibrium. A system that arrives at an unstable state is prone to a catastrophe — invasion of pests, disease, or crisis — which changes a system dramatically or often drives it to collapse. That is the reason why the book is called *Catastrophes in Nature and Society*.

Classification and prediction of catastrophes is the subject of the catastrophe theory by Rene Thom. Yet, its topological methods cannot

provide quantitative predictions so urgent in practical applications. On the other hand, the traditional approaches of mathematical physics implying differential equations are inapplicable to complex systems. The authors of the book approach the subject of complex systems using phase portrait modeling which is closely related to Newton's steepest descent and is thus as classical as differential calculus. Viewed in the context of phase portraits, the processes that seem disconnected and chaotic at first sight show up in their consistent intrinsic logic.

The book written in a popular manner presents the results of original studies by the authors which were partly reported earlier in scientific journals but many come out for the first time in this publication.

The suggested models of mechanisms behind the evolution of nature and society are of great theoretical and practical value. Their understanding and proper use can reduce the risks that threaten our civilization and eventually bring to harmonic coexistence of economy and environment instead of their today's antagonistic confrontation. One can expect that the book will make for better awareness of readers willing to participate in solving the vital environmental, economic, and social problems of our time.

Professor S. Gabuda