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6 F. Müller et al.

the potentials of modelling, data management, and statistics are demonstrated. One of the actual theoretical fields mentioned in the introductory chapter is described in more detail in the second chapter: Feth and Müller analyse environmental change as an explication of self-organized trajectories. Some basic ideas about ecosystem growth and development are reviewed, and the classical succession approach is linked with actual concepts of collapse, break down, and decay. While these two chapters are highlighting the necessity of long-term ecosystem research from aspects of systems theory and thermodynamics, Schimming et al. are illuminating long-term research conceptions in relation to environmental monitoring activities. Of course both branches of environmental analysis can mutually profit from each other: Scientists can be enthusiastic interpreters of monitoring data to better solve their long-term problems, and on the other hand, these solutions can be extremely valuable for any application in environmental management. As long-term management concepts should be developed although they are actually available only in a small portion, this symbiosis should be enhanced in the future.

Part III: Exploring long-term processes – International experience: The chapters of this section are dealing with the following questions: *How are LTER programmes developing? Which are their typical concepts, results, and research questions? Which experience has been made in the utilization of specific long-term related methodologies?* These questions are discussed from different viewpoints: Initially Gosz et al. report about 28 years of the US-LTER Program. The authors demonstrate the goals of their exemplary initiative, its history, motivations, and outcomes, the organizational structure, and the challenges which US-LTER scientists will be facing in the future. In many points those research demands are also realized by ecologists in Europe as demonstrated in the chapter of Mirtl.

In the two subsequent theoretical chapters, the potentials of ecosystem modelling are described by Gnauck et al. which concentrate on the powerful tools of statistics and their applications in long-term ecology. Hostert et al. additionally show the role of remote sensing techniques and their contributions for the mission of LTER, illustrating theoretical approaches as well as examples from the US LTER Programme. Of course, besides remote sensing, many basic methodologies are applied in long-term ecosystem research. Several examples can be found in the next section.

Part IV: Concepts and results: Presenting and interpreting long-term ecological processes: In this section, the following questions are discussed: *Which are the basic results of existing long-term research projects? Which processes have been observed in different ecosystem and landscape types? Which are the main results of these investigations? How can those results be used to link research and application?*

In this part (IV) case studies from *different aquatic ecosystem research* projects are presented. Starting with interesting experience from several coastal time series van Beusekom et al. demonstrate recent changes in the ecological structures and functions of the Wadden Sea ecosystems in Northern Germany. Their main questions are related to the consequences of temperature, salinity, and nutrient changes, the consequences for plankton and benthos communities, and the influence of alien species, which can be observed very realistic in the Wadden Sea. Stockmann et al. are expanding the aquatic research area, searching for externally forced signals in biological time series in the overall North Sea. The authors are using extensive simulations of varying external physical factors to explain the trends and shifts of biological parameters. A third type of aquatic ecosystems is described in the chapter of Schubert et al.: Based on several long-term data sets, typical developmental tendencies in brackish ecosystems are reported, including gradient-related comparisons of the Baltic Sea, coastal lagoons at the Baltic and Chesapeake Bay. The authors underline the necessity and the added value of long-term investigations to better understand these highly variable systems. Finally long-term developments in two fresh water ecosystem types are described: On the one hand, Köhler shows recent drivers, pressures, and impacts on lake ecosystems, taking into account the consequences of eutrophication, acidification, species invasions, and climate change, stressing the potentials and limitations of long-term research concepts. On the other hand, Poschlod et al. present the results of long-term monitoring investigations in rivers of South Germany since the 1970s. The authors are using macrophytes as focal indicators for the assessment of water quality.

Part V refers to the results of *terrestrial ecosystem research* investigations. Also in this part of the