

Preface

Since the first publication of the German textbook *Systemanalyse: Einführung in die mathematische Modellierung natürlicher Systeme* by Dieter M. Imboden and Sabine Koch in 2003, many things have changed in the academic world. Others have remained firm and constant; one of them is the central role of the mathematical language as the common basis to express the ever more complex findings of scientific research. In fact, an introduction to the principles of mathematical modeling should still be part of the foundation of every university science curriculum.

At the same time, teaching is becoming more international, especially at the world's leading research universities (to which ETH Zürich proudly belongs). This in turn means that even in non-English-speaking countries, English has become firmly established as the lingua franca in the classroom. In fact, the first author (Dieter Imboden) was often asked for an English version of the book. Among those who contacted him was one of his former students and a young researcher, Stefan Pfenninger, at the time working at the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. Dieter responded with his regrets over the lack of an English version of the book and spontaneously suggested to Stefan to help prepare one. Sabine Koch, the junior author of the German book and by now a successful ecological winemaker in Southern Germany, enthusiastically supported the idea and was happy to yield the junior author position to Stefan. The cartoonist Nikolas Stürchler, who had meanwhile joined the Swiss Diplomatic Service (where he is rumored to use his skills livening up drab international treaties), agreed to have his cartoons incorporated into the English version as well. Thus, cheeky Dang, muddle-headed Professor Dong, and clever dog Ding are still here to help the reader digest all the equations with humor and (sometimes) deep philosophical insight.

Since the concept of the book has been proven in the lecture hall time and again, we kept changes in the translated version to a minimum. With a few exceptions, the numbering of equations, figures, tables, examples, and problems correspond one-to-one to the German version. This will facilitate the use of the book for lectures in which students are using either version. The major exceptions to this are as follows. In Chap. 4, Example 4.13 has been moved before the explanation of the two extreme cases (slow/rapid fluctuation). The chapter ends with a new example on lake temperature (Example 4.14), which was taken from Problem 4.6 of the German edition.

Consequently, Problem 4.6 now refers to a modified situation of that lake temperature problem. The two other modifications are the addition of Problem 6.9 (competition for living space) and the replacement of Problem 8.7 by a more realistic example (transport and reaction in a lake's water column).

The book is firmly rooted in the algebraic formulation of mathematical models, their analytical solution, or—if solutions are too complex or do not exist—in a thorough discussion of the anticipated model properties. The reader will find neither mathematical proofs (just a summary of some useful equations in the Appendix) nor any specific reference to the many existing software tools. The latter make life easy for today's modelers, but they can also produce a false sense of security. We firmly believe that the user of such software should always be able to interpret the result of computer simulations, and that is only possible if she possesses at least a basic mathematical understanding. That being said, we also recognize the importance of connecting directly and visually to one's work and the ease with which modern software allows us to formulate and solve modeling problems. We therefore prepared interactive examples for several of the models presented in the book on the web as an additional aid in understanding the underlying principles (see the book website at www.systems-analysis.org).

Once again, the authors of the book were blessed with numerous favorable circumstances. After Dieter became President of the Research Council of the Swiss National Science Foundation, the principal Swiss public research funding agency, Nicolas Gruber succeeded him as environmental physics professor at ETH Zürich. Nicolas aided the development of the book in myriad ways: He graciously provided funding for travel and other expenses and provided feedback as well as new material.

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