

Preface

In December 2000, the conference “New Challenge of Eco-city Development in 21st Century” was held in Macao by the Ecological Society of China. At this conference, one of us (Lei) first encountered the theory of ecological economics. Since then, Lei has become increasingly concerned about the sustainability of his home city, Macao. Macao is a city with a dense population that depends heavily on exogenous natural resources, but benefits greatly from the gambling and tourism income that flows into the city. Residents benefit greatly from the high net influx of materials and energy into Macao, and as a result of these inflows, the standard of living of the citizens has steadily increased during the past 30 years.

However, there are concerns over whether the city’s rapid development is sustainable. Sustainable development combines concerns about the carrying capacity of the natural systems that sustain human systems with concerns about the social challenges faced by humanity, and particularly the need for socioeconomic development. For development to be sustainable, it must meet the needs both of humans and of the natural environment. To study Macao’s sustainability, it was necessary to choose an approach and a system of metrics that could relate the natural environment’s flows to those of the socioeconomic system. Based on a careful review of the literature, Lei chose emergy synthesis. Emergy synthesis measures the flows of materials, energy, commodities, money, and services, and can easily quantify these values within a common analytical framework that integrates all the flows and allows direct comparisons among them. The clear advantage of emergy synthesis is that it combines the most insightful features of the ecological and economic methods of analysis, thereby providing a complete picture of the human and environmental meaning of the flows.

In this book, we have used the emergy synthesis approach to develop an accounting model that is suitable for describing systems with relatively clear boundaries, such as an urban system, thereby providing a comprehensive picture of the system. Our book has eight chapters, and is organized as follows:

Chapter 1 gives a general introduction to the basic theoretical background for emergy accounting and related fields, and defines many of the key parameters and indicators used in emergy studies.

Chapter 2 first presents a detailed emergy accounting for Macao in 2004, followed by a time series of the emergy flows in Macao's system from 1983 to 2004 and a comparison with Italy and Sweden to put these values in perspective. Finally, we present a statistical analysis of Macao's emergy-based indicators.

Chapter 3 presents the results of simulating Macao's system using the STELLA dynamic modeling software to investigate and characterize the evolution and development of Macao's natural and socioeconomic systems from 1983 to 2003. Based on the simulation results, we also predict the evolution of these systems in the coming 20 years and its relationship with the ongoing land reclamation from the sea that is occurring in Macao.

Chapter 4 focuses on an emergy accounting for the city's tourism industry. First, we introduce the historical evolution and economic contributions of the tourism industry, followed by a detailed emergy calculation and assessment of its contributions and impacts from 1983 to 2004. Finally, we determine the net emergy for Macao's tourism industry and draw conclusions about this sector's impacts.

In Chap. 5, we analyze the emergy flows in the gambling sector. Gambling and related tourism activities represent a special form of economic and societal activity, and have been crucial to Macao's success.

Chapter 6 describes a detailed emergy accounting of waste treatment in Macao, including some pioneering efforts to include previously neglected flows such as gaseous emissions. We describe the related feedback ratios for solid wastes, sewage, and gaseous emissions and use the results to determine the efficiency of Macao's waste treatment and calculate the transformities of these wastes using Macao's waste discharge data.

Chapter 7 shows how a comparison of the carrying capacity of a city's or a region's natural resources with the consumption of these resources at regional or global scales can reveal the system's sustainability. To illustrate how this comparison works in practice, we performed a case study of 17 representative countries, using data obtained from the National Environmental Accounting Database, and the results confirmed that to ensure long-term sustainability, it will be necessary to control population increases, reduce emergy consumption, and promote emergy efficiency.

Chapter 8 provides a final summary of the previous chapters, and identifies problems that will require additional research, as well as some shortcomings of the ecological energy accounting approach. It concludes with a research outlook for future researchers.

This book is intended for readers who want to learn more about how hybrid natural and socioeconomic systems function. This includes researchers and graduate students working in the fields of systems ecology, energy accounting, environmental management, and related areas. Readers will obtain a comprehensive understanding of the methodology of emergy synthesis, and of the dilemmas that government planners face as a result of the need to sustain socioeconomic development while protecting the environment, which will ultimately lead to sustainable socioeconomic development. We hope that by making this book available to students and researchers, we will promote the development of emergy analysis skills and increase knowledge of

the importance of ecological energy accounting. We also hope that readers will be motivated to find ways to improve on the methods we describe in this book.

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Macau, China
Guangzhou, China

Kampeng Lei
Shaoqi Zhou
Zhishi Wang

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Lei, K.; Zhou, S.; Wang, Z.

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