Preface

Climate change, resulting from increasing carbon dioxide (CO_2) emissions from large-scale human activities, has caused significant environmental and humanitarian crises in recent years. So extreme are some of these frequent extreme weather events, development is now being threatened in many places in the world. If anthropogenic CO_2 emissions are allowed to increase without the imposition of appropriate restrictions, climate change and the related natural disasters will further destroy the environment, seriously threatening not only human existence but all life on earth.

To control these increasing extreme climate change risks and protect the environment, "low carbon development" (LCD), which is a combination of technological innovation and lifestyle changes, needs to be the focus of future development in the whole world. One of the most compelling reasons for pursuing LCD is that the potential impact of climate change is predicted to be severe in both developing and developed countries. Therefore, the pursuit of CO_2 emissions reduction could possibly lower the risks of future catastrophes. As a result of this need to look to the future, "low-carbon" awareness is entering the development lexicon, and adding an important climatic dimension to the concept and discussion on sustainable development. The United Nations Framework Convention on Climate Change (UNFCCC), as the foundation international treaty responding to global climate change, is a key indicator of this focus. Out of this foundation has arisen international agreements, such as the Kyoto Protocol to the United Nations Framework Convention on Climate Change signed in Kyoto, Japan in 1997, which set detailed emission mitigation commitments for the 38 major industrialized countries. Although the protocol did not specify an explicit CO_2 reduction obligation for China and other developing countries, these nations also face great pressure from the worsening environment.

The significant attention LCD has attracted from national administrations and researchers has led to many different interpretations of what constitutes LCD. However, it has been globally recognized that as populations and economies grow, increasing amounts of carbon dioxide are put into the atmosphere posing a serious threat to the earth's environment from the resulting climate change and its associated extreme weather events. In this context, the notions of "the carbon footprint", "low carbon economies", "low carbon technology", "low carbon lifestyles", and "low carbon cities" have arisen from which new national and

international policies are emerging. Low carbon development has become an achievable focus for the goals of carbon emissions reduction and the realization of sustainable development.

Because the increased concentrations of key greenhouse gases are a direct consequence of human activities, scientific consensus is steering global action towards emissions reduction and the transition to a low carbon economy. As a result, some developed countries have substantially adjusted and continue to adjust their socio-economic policies towards low carbon development. However, despite broad agreement on the need for large long-term global emission reductions, the great challenge remains burden sharing across countries. Developing countries are asking the developed world to take responsibility for their past emissions, and commit to substantial emissions reduction. Developed countries, on the other hand, demand that the large developing countries and emerging economies, which are growing significantly in terms of economy and population as well as carbon emissions, should also curb their emissions within certain limits. To ensure the continuing development of regional economies in developing countries then, it also becomes an urgent task to reduce emissions and lower carbon intensity through logical planned LCD growth.

Regional development cybernetics is an innovative approach towards low carbon economics based on cybernetics, which was defined by Norbert Wiener in 1948 and refers to the use of a systemic idea to simulate and solve complicated problems. The cybernetics approach uses a series of systemic models to develop a problem framework and model system, scientifically describes the relationship between them, and integrates their functions. As the low carbon economy is a new economic direction which has the goals of enforcing economic growth, improving social progress, and maintaining the ecological balance by the means of exploiting renewable energies and reducing CO_2 emissions, the use of cybernetics at the regional level is considered one of the most efficient methods to overcome climate change difficulties and to promote low carbon development. While the cybernetics approach requires that all sectors, such as industry, government, and the citizens, and all levels, including global, national, and regional levels, engage in this closed loop action, the implementation of climate strategies depends heavily on the regional level.

The regional low carbon economic systemic model has at least nine subsystems; greenhouse gas control, ecological capacity evaluation, regional economic prediction, energy structure optimization, land resource utilization, industrial structure adjustment, low carbon industrial chains, low carbon transportation, and low carbon tourism. A systems model needs to describe and represent all aspects of a complex system, such as planning, analysis, design, implementation, deployment, structure, behavior, input data, and output data. In this book, a systems dynamic model based on multi-objective optimization is introduced to simulate low carbon development in realistic situations and which offers some valuable suggestions for decision makers planning for regional low carbon development.

By developing quantitative methods to determine a path for low carbon economics, decision makers are provided with many effective strategies to plan for key problems in the nine subsystems. This book also hopes to provide researchers with a new perspective from which to pursue solutions to some social problems using a quantitative technique.

This book has 11 chapters, each of which focuses on different aspects of the development of a low carbon economy. Chapter 1 outlines the reasons why the pursuit of a low carbon economy is the optimal path for sustainable development in an environment affected by climate change, and the progress, concept, and practice of low carbon development is investigated. Then a systemic analysis method is used to examine the relationship between sustainable development and climate change to introduce the key problems affecting the low carbon development of a regional economy. The pedigree structure of the cybernetics for low carbon economics, which is made up of the total flow path, the problem framework, the model system, the meta-model and general equilibrium, is constructed by conducting a background review, developing system statements, modeling the system, devising a solution method, and applying the method to a realistic case study. Some key scientific problems for the nine subsystems identified in low carbon development are discussed in Chaps. 3–11. Several quantitative technologies such as the systems dynamic model, the multi-objective optimization model, the ecological footprint model, and the econometric model are introduced to assist practitioners achieve the goal of low carbon development in a regional economy. Every chapter provides decision makers with many effective strategies to develop a comprehensive, effective plan.

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