Preface

The world is facing an urgent need for economic, social and environmental transformation, requiring huge efforts for pursuing a sustainable future. In 2015, all 193 United Nations (UN) member States adopted the Agenda 2030 with its 17 Sustainable Development Goals (SDGs) — a comprehensive framework comprising many potentially diverging policy goals and aspiring for transformative change in the economic, social, and environmental challenges. These challenges are strongly interlinked, in fact, SDGs are expected to be mutually supportive and need buy-in from all nations. This means that governance processes across multiple sectors, stakeholders and countries are critical and long-term social and economic improvement will need closer attention to be paid to the environment. Meanwhile, great efforts must be made to reduce or change human use of geophysical resources (such as energy, materials or land) to prevent severe ecological degradation and mitigate climate change effects. Climate action is explicitly addressed by SDG13, and is expected to impact almost all aspects of sustainable development, so it is necessary to understand how action to address climate change could reinforce or undermine the other SDGs, and vice versa. A quantitative and comprehensive research is therefore mandatory to link the social, economic and environmental fields, aiming at guiding and monitoring the progress to sustainable levels.

At the core of sustainable development science is therefore the need to understand the interactions between Society and Nature, how these interactions change over time and how they will be likely affected in the next future. Metabolic research is an effective system approach for analysing the physical exchange process (material and energy flow) between human society and its natural environment as well as the material and energy flow within human society, and their impacts to the natural environment. SDGs framework introduced a set of detailed monitoring indicators related to metabolism, such as domestic material consumption (DMC), material footprint (MF), resource efficiency, and so on, while scholars from different backgrounds have developed various research strands of socio-metabolic approaches. SMR is based on the assumption that social systems and ecosystems are complex systems that can replicate themselves, affect each other, and develop together over time. System components at different scales tend to act and influence each other by nesting within another. Moreover, scale matters in a wide variety of aspects of driving forces, impacts, and responses to sustainable development challenges, because it is directly related to how and where governance decisions are made. This requires new approaches to multi-scale actions, as far as cross-scale innovative co-management structures can promote sustainable development. As a matter of fact, local decision-making is

influenced by regional policies, which in turn affects global politics and economy, rising from local to larger scales, and the decisions in turn affect sustainable development: what happens to sustainability at one scale affects sustainability at other scales.

As an increasing number of people and human activities are concentrated in cities, with more than 55.3% of the world population living in urban areas, thus cities bring significant and increasing economic contribution to their economies. More and more researches are focused on the urban-scale operation and functioning. However, the environmental issues of cities extend outside the urban boundaries, not only involving multiple dimensions, but also scales of impacts ranging from local, regional to global. This requires larger scales of analyses, taking into account the interaction of urban to national to even global scale. Urban metabolism has been used as a metaphor in multiple fields, indicating that traditional methods may not have fully epistemological tools to face the new challenges, including sustainable development ones. Research has now recognised the importance of scale. So far, metabolic research has been applied to multi-scale research from individual/family, neighbourhood and urban spatial scales to regional and even global scales, as well as from individual sectors to socio-economy. Several questions raised: ① being metabolic research applied to complex systems at different scales, what are the main differences among the research methods at different scales?②From the perspective of historical development of metabolic theory, what are the focuses at different stages, and which ones should draw more attention in the future?

This book contributes to the understanding of the differences of metabolic research applied at different scales. Based on the literature, it outlines the origin and development of metabolic theories and studies at different scales, as well as their analytical methods of metabolism research, and finally puts forward the significance of scale-up framework in metabolic research. We recognize that this book can offer something of a “voyage of discovery” for teachers and students with the background of system ecology, environmental sciences and ecological economics, and also for urban planners, and policy makers.