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# Climate Change, Supply Chain Management and Enterprise Adaptation

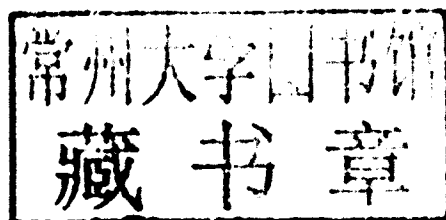
Implications of Global Warming on the Economy



COSTAS P. PAPPIS

# Climate Change, Supply Chain Management and Enterprise Adaptation: Implications of Global Warming on the Economy

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## Foreword

This book on Climate Change, Supply Chain Management and Enterprise Adaptation is very timely. Its topic is of critical importance as it deals with issues that are taking centre stage on the agenda of international politics, business, the media and society at large. Climate Change is without doubt the largest threat to our planet.

This book is also important to Supply Chain Management since the latter has great potential to mitigate Climate Change effects. The business world needs to adapt to the challenge of climate change and fulfil its corporate social responsibility role. Increasingly, big companies are announcing climate change mitigation actions in their CSR reports.

The author provides a detailed explanation of the climate change phenomenon and its impacts on the economy and environment, based on reliable sources like the IPCC Reports and the Stern Review, which he summarizes well. The book contains appropriate and up-to-date background information and literature review. Many short case studies and references can be found throughout the text.

Writing this book was a challenging task. It required coming to terms with heterogeneous issues like Climate Change, Supply Chain Management and Enterprise Adaptation. These issues required adequate handling and their interrelationships had to be analyzed.

I believe the final result is great in that the issues and trends are given a proper and balanced treatment. The book can therefore be recommended as a high-quality resource to the interested reader.

The target audience includes business people, regulatory authorities as well as academia, i.e., researchers, teachers and students from related disciplines like business and environmental management. However, skipping the more technical parts, the general public may also find this book useful and informative.

*Luk N. Van Wassenhove*  
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**Luc Van Wassenhove** (Foreword). Professor Van Wassenhove's research and teaching are concerned with operational excellence, supply chain management, quality, continual improvement and learning. His recent research focus is on closed-loop supply chains (product take-back and end-of-life issues) and on disaster management (humanitarian logistics). He is senior editor for *Manufacturing and Service Operations Management* and departmental editor for *Production and Operations Management*. He publishes regularly in *Management Science*, *Production and Operations Management*, and many other academic as well as management journals (like *Harvard Business Review* and *California Management Review*). He is the author of several award-winning teaching cases and regularly consults for major international corporations. In 2006, Professor Van Wassenhove was the recipient of the EURO Gold Medal for outstanding academic achievement. Before joining INSEAD he was on the faculty at Erasmus University Rotterdam and Katholieke Universiteit Leuven. At INSEAD he holds the Henry Ford Chair of Manufacturing. He is also the academic director of the INSEAD Social Innovation Centre.

## Preface

This book aims to provide one among many diverse responses to a growing sense of urgency fed by climate change and felt at all levels of social life, including international institutions, governments, local authorities, and enterprises. It is set up as an interdisciplinary treatment of issues raised by climate change in connection with its implications for the society, environment and economy, particularly at the company and the supply chain levels, and as an aid to decision makers, being they government officials or business analysts, in their endeavor to meet the economic, social and environmental challenges posed by global warming. It is a synthesis of facts, arguments and research results found in the literature aiming to contribute to the work made in various related fields and disciplines, and shape a better understanding regarding the serious impacts of climate change on enterprises, supply chains and global economics, the implications for management, and the decision making tools and scientific background available for formulating adaptation and/or mitigation policies. Its target audience includes business people, management staff, regulatory authority staff, teachers, researchers and students in Business Management Departments and, finally, any reader interested in the major challenges that society and economy, and actually the whole planet, is faced with.

Mounting scientific evidence shows that Earth's climate is dramatically changing due to the greenhouse emissions caused by human activities, notably by burning fossil fuels for energy production and transport and other uses. The economic growth that followed the Industrial Revolution and the progress of Supply Chain Management that resulted as a necessity from trade explosion and globalization led to global warming. Climate change, a result of global warming, is bringing severe phenomena along with it, causing, among others, extreme weather events, disruption of supply chain operations, dislocation of industrial, agricultural, recreational and commercial activities, increase of living costs and loss of consumer power, desertification of lands, dramatic decrease in biodiversity, sea level rise, and damage to natural habitats

and ecosystems. Some of these impacts can be observed already, while others will be visible soon. In general, the major impacts of climate change are long-term and, to mitigate its effects, governments have to take (and are actually taking) action right now. However, the long-term nature of the problem must not draw attention away from the fact that different sectors are facing its effects even now.

While our world is increasingly becoming uncertain and risky, climate change is proven to be one of the major contributors to current instability. Decision making under climate change has to consider some new risks, albeit accompanied with some conditional opportunities. Supply chains and enterprises, in particular, are increasingly proven to be extensively vulnerable to climate change, posing to management new questions demanding urgent answers. Indeed, climate change has very significant consequences regarding the performance of supply chains and enterprises, many of which are faced with the danger of serious damage, even collapse, for several reasons, including big changes in the structure of markets, the uncertainty of availability of raw materials and components, higher transportation risks and costs, flooding, higher insurance and energy costs, etc.

How to accommodate risks, set strategies for future development, and properly address climate change at the company level? In fact, not all companies are faced with the present and prospective risks, depending on what are the types of their assets and where they are located, what they produce, what types and amounts of energy they use, etc. Furthermore, there are leaders in the business world that have developed corporate practices which take climate change risks and opportunities into account and take respective action; they recognize the threats posed and opportunities opened by global warming at board of directors level, they consider them as a near-term priority, they develop relevant strategies, they participate in collective initiatives, and they adopt formal reporting systems that show their preparedness to undertake action, including efficient production processes and supply chain operations and effective use of energy. Climate Leaders, an industry-government partnership in the USA created by the Environmental Protection Agency that works with companies to develop comprehensive climate change strategies, is a characteristic example. In Climate Leaders' site (<http://www.epa.gov/stateply/casestudies/index.html>), where several case studies from different industries are reported, it is well supported that environmental friendly company, and more generally, supply chain management may be practical and effective (consider, for example, the relation between improved energy efficiency and reduction of greenhouse gas emissions). Thus, there are several success examples, but what is important is that there are tools and techniques available from operations research and management science, which may be helpful for the above tasks. One of the main tasks of the book will be to outline relevant frameworks of decision analysis.

The subject to be treated in this book is the implications of global warming for world economy, focusing on supply chain management and enterprise adaptation. The tools and frameworks available for setting strategies and making decisions under uncertainty, as well as the risks implied by climate change, are in the core of the presentation. Starting with a reference to the present situation and trends regarding the enterprise in the beginning of the 21st century, particularly in an “extended enterprise” framework, the social responsibility of enterprises, particularly its contribution to sustainability, are discussed. The basic facts about climate change are outlined, its impacts on the economy and society are presented, and issues of climate change adaptation and mitigation are discussed. Reference is made to stories from the world of enterprises referring to adaptation strategies and practices undertaken to cope with climate change. Frameworks for decision making regarding issues of business design and operation under risk and uncertainty implied by climate change are also presented. The amount of literature covering the different disciplines, from which this book has borrowed wisdom and knowledge, is immense. Therefore, only a very limited subset of sources used have been cited, in particular those that have been considered as most helpful to the author’s task to narrate the thrilling story of the book’s subject.

The book is structured as follows:

Chapter 1 explores some of the features of today’s enterprise considered to be most important, particularly in view of the main topics of this book. Extended enterprise and corporate social responsibility, two of the most fundamental topics for the business world that emerged during the late 20th century and are shaping a modern enterprise, are discussed. Also, new risks and challenges that arise from the environment of the 21st century enterprise, several of which are directly or indirectly related with climate change, are presented.

Chapter 2 introduces the basic facts regarding global warming, based almost exclusively on the latest scientific findings as reported in February 2007 by the Intergovernmental Panel on Climate Change’s Fourth Assessment Report, particularly the Report of the Working Group I on the Physical Science Basis of Climate Change. The facts concern observed changes in atmospheric constituents and in radiative forcing, surface and atmospheric climate changes as well as changes in snow, ice, frozen ground and oceans.

In Chapter 3 the issue of the global impacts of climate change is treated. The discussion is based on findings of the Stern Review on the Economics of Climate Change, considered to be the largest, most widely known and discussed and most influential of the reports assessing the impacts of climate change on economy and society so far. A broader reference to the discussions raised by the Review’s proponents and opponents is also made.



In Chapter 4 the subject of the cause-effect relationships between climate change and supply chain operations is treated. The contribution of specific operations along the supply chain (related to production, transportation, warehousing and storage, trading, consumption and customer service) to global warming is discussed. Correspondingly, it is shown how the environment impacts on such operations. The effect of Technology, particularly Information Technology, on the relation between climate change and supply chain operations is also explored.

Key climate adaptation concepts are introduced and the issues of climate adaptation in the developed world as well as in developing countries are discussed in Chapter 5. The subject of the particular position of the company in reference to climate change is subsequently treated and the range of incentives or barriers that could encourage or prevent climate adaptation is explored. The economic framework for climate adaptation is also elaborated.

Chapter 6 introduces the issue of climate change mitigation policies. Drivers of global greenhouse gases emissions' increase are presented and the problem of stabilization of greenhouse gas concentrations is discussed. Instruments of mitigation, including the Kyoto Protocol, carbon trading, the Clean Development Mechanism and

Joint Implementation, as well as related technology policies, are presented. Shifting to new or improved technologies, technological options, power generation technologies, technological developments in other areas and the case of biofuels are discussed. The chapter also makes reference to the issue of change of preferences and behaviour.

Chapter 7 focuses on business responses to climate change. Some well-known paradigms and collective initiatives will serve as reference of where the business world is moving on. Specific reference to the Carbon Disclosure Project, the CERES Report and other important greenhouse gases programs and initiatives is made. Several company examples are presented, together with examples of sectors moving ahead and domains of new opportunities among sectors emerging from climate change.

In Chapter 8, approaches to coping with risk and uncertainty in policy making, particularly in a climate change context, are presented. The presentation includes four decision analysis frameworks, namely, the UNEP, the UK Climate Impacts Programme, the Australian Greenhouse Office and the Ministry for the Environment of New Zealand frameworks. Uncertainty and risk are particularly related with the insurance industry, a sector increasingly affected by the impacts of climate change in terms of accelerating trend of liabilities, costs and losses. As relevant developments in all other sectors of the economy are reflected on this sector, it was thought meaningful to make specific reference to the insurance industry.

Finally, Chapter 9 presents an overview of the above four decision analysis frameworks, which were selected with the major criterion being to serve the main purposes of this book, and more specifically, to be of the widest applicability, with proper adjustment, not only by government officials but also by decision analysts at company level. Issues such as frameworks' scope and structure, generic issues, stages for decision-making, tools and techniques are also discussed.

Summarizing the above, it is evident that climate change has become the topmost environmental issue, with extremely serious economic and social implications, that societies, governments and businesses are faced with. As the emissions continue to grow despite efforts made and commitments undertaken, their impacts on climate change felt so far, and, even more, the ones anticipated, leave no space for doubt that strong concerted action is urgently needed at all levels, from corporation to city, as well as national and international institutions, to address the challenges and reverse current trends. Companies, in particular, should know how to identify and assess the risks arising from climate change and develop action plans for adaptation covering all aspects of the challenges their supply chains will encounter.

Nevertheless, the author shares the conviction of many others that, in view of the unprecedented challenges posed to mankind by current global warming, complicated as they are by other socio-economic problems of the planet, a new world paradigm is urgently needed for a sustainable planet, based on different patterns of social organization, production and consumption, where a different value system is endorsed, which pays due attention to environment and life on Earth. The solution approaches presented in this book promise to accommodate somehow, in the near or distant future, some of the current problems, and avoid a total collapse. However, under the currently prevailing values and models of life, and despite whatever sacrifices may be accepted by human society while these values continue to prevail, it is difficult, if not impossible, to see how Earth may sustain life, full of the treasures of biodiversity and of opportunities for every human being to live in harmony with nature and society. Therefore, to the author's view, a radical departure from the current predominating values and models of life, towards sustainability, seems to be imperative.

## Acknowledgment

Over the years, a very large number of individual scientists, research groups, public national and international organizations and institutions, as well as companies and company associations, have contributed to the building of knowledge and understanding of the facts, ideas and laws governing the issues discussed in this book. From the plethora of scientists and other contributors to this treasure of knowledge and wisdom, for whom a list of acknowledgements would be infeasible to draw up, I gained invaluable insights and understanding and a motivation to write this book on the implications of global warming for the enterprise, supply chains and economy. To all of them I confer my gratitude for their assistance in writing the book.

My special acknowledgement goes to the members of the International Panel on Climate Change and all the distinguished scientists who have contributed to its reports. These reports have been among the major sources used in order to document the basic facts about climate change, which is the subject of Chapter II. This holds also for the contributors to the famous Stern Review on the Economics of Climate Change, and its inspirator, Sir Nicolas Stern, whose report has been extensively used in this book in order to document particular impacts of climate change on the economy and society, which are treated in several parts of the book. These extremely valuable documents, fundamental for the knowledge we have about climate change and its impacts on society and economy, have been given worldwide publicity and are freely accessed on the Internet. In this book, they have been the source of many, sometimes lengthy, quotations used to substantiate diverse facts and arguments elaborated in most chapters.

A special note of appreciation and thanks goes also to a number of friends, and ex- or present Ph.D. students of mine, distinguished scientists and close collaborators, who were willing to go through and comment on parts of the book. I would like specifically to mention Prof. Nikos I. Karacapilidis for his invaluable advice. Mr. Thomas Dasaklis, M.Sc., Ph.D. student, has provided me with his valuable support

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