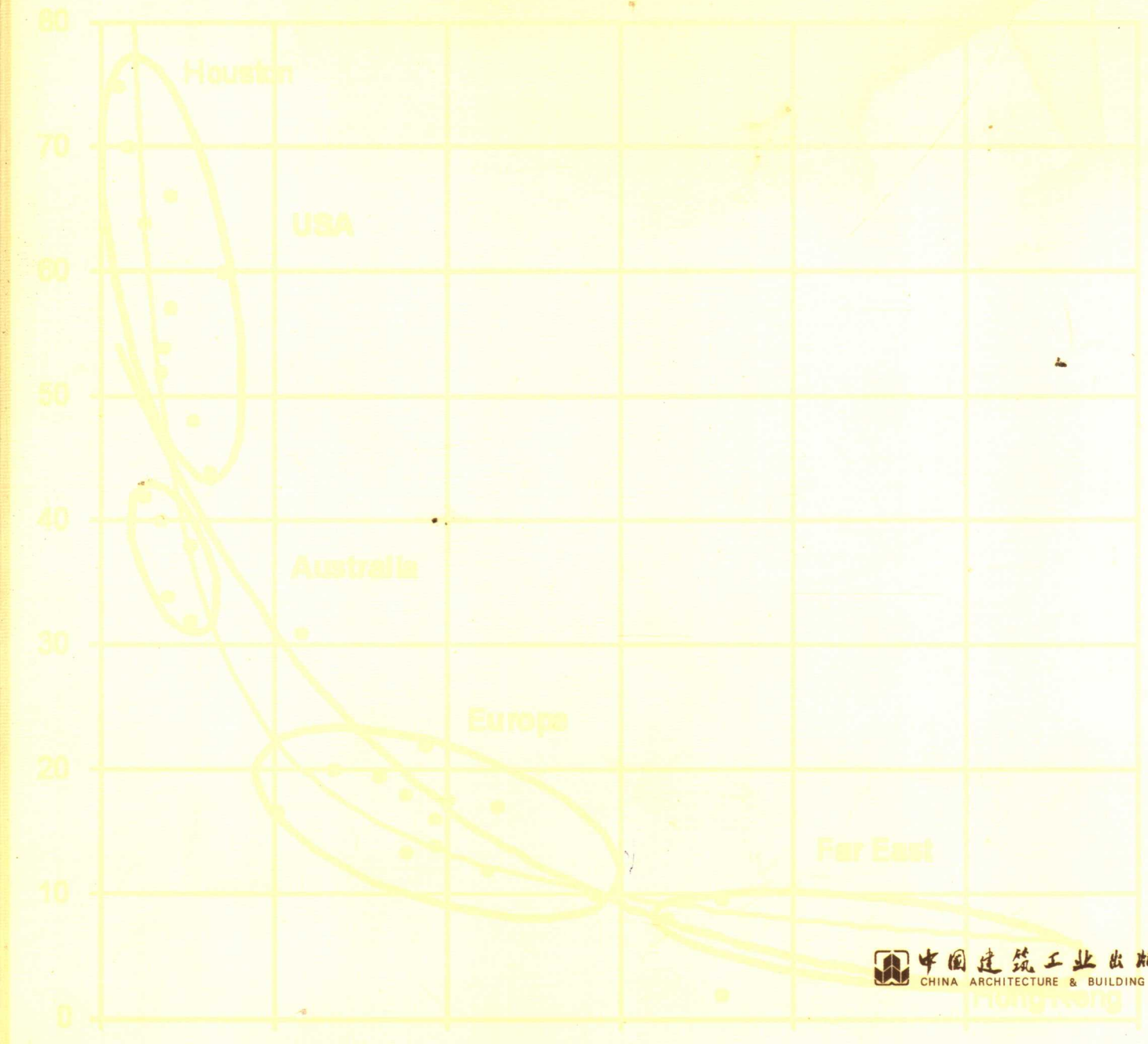
Sustainable Urban and Architectural Design

可持续城市与建筑设计（中英文对照版）

Runming Yao, Koen Steemers, Baizhan Li
姚润明　昆·斯蒂摩司　李百战 著



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这是一本面向中国读者的、全面论述了可持续建筑设计关键问题的著作。全书共4章：第1章介绍了气候变迁的影响，以及在可持续城市与建筑设计中，建筑专业人员所面临的挑战和应起的作用。同时也介绍了中国建筑能源消耗的一些信息；第2章主要介绍城市设计问题。如城市形态、城市密度和城市微气候，并讨论了能源供求以及城市舒适问题；第3章主要介绍能效建筑设计。首先，作者介绍了建筑设计的气候条件与舒适及工效问题。然后介绍了能效建筑设计的理念与方法，如建筑围护结构、自然通风、太阳能利用、自然采光以及可再生能源等。最后，作者介绍了新开发的建筑方案设计工具；第4章介绍了世界上可持续城市与建筑设计和营建方面的实例。这些最佳实例既有新建建筑，也有现存建筑；既有单体建筑，也有大型社区。主要涵盖的建筑类型有：办公建筑、学校建筑、宾馆建筑，以及住宅建筑。主要的地理位置及气候特征涵盖了中国建筑热工设计的大部分气候区。

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前　言　Preface

21世纪初始，气候变迁已成为世界面临的最大挑战之一。由于化石燃料的燃烧所带来的温室气体排放被认为是造成全球变暖的主要原因。目前，中国的建筑能耗已占到总能耗的28%，预计到2010年将上升到1/3。大量的经验表明通过能效建筑设计可以达到显著的节能效果，因此，可持续城市与建筑设计在温室气体减排与环境保护方面将起着重要作用。本书旨在介绍可持续城市与建筑设计方面的理念、方法、技术以及优秀实例。本书可作为建筑学、城市规划、建筑环境与设备工程专业学生的参考书或专业英语教材，同时也可作为设计及工程技术人员的设计指南。

Climate change is one of the major challenges facing the world at the start of the 21st century. Greenhouse gas emissions due to the burning of fossil fuel are considered the main cause of global warming. China's buildings sector currently accounts for 28% of China's total energy use and is projected to increase to one-third by 2010. Experience has shown that significant energy savings in buildings can be achieved through energy efficient design, therefore sustainable urban and architectural design will play an important role in mitigating emissions and environmental protection. This book aims to introduce the concept, methods, technologies and best practice examples of sustainable urban and architectural design. It can be used as a reference book or a specific course English language teaching material for Chinese students of architecture, urban planning, building services and environmental engineering. It can also be used as design guidance for architectural and engineering professionals.

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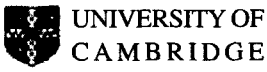

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Content

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Chapter 1 Introduction

1.1 The problem of climate change

Climate change is one of the major challenges facing the world at the start of the 21st century. The mean global surface temperature has increased by about 0.3 to 0.6℃ since the late 19th century and by about 0.2 to 0.3℃ over the last 40 years, which is the period with most reliable data. Recent years have been among the warmest since 1860 - the period for which instrumental records are available. For example, the global average surface temperature in the year 2002 was approximately 0.8 ℃ above the average temperature at the end of the 19th century, making it the second warmest year in the 142-year global instrumental temperature record. The average land temperature was almost 1.2 ℃ above that at the end of the 19th century. The year 2004 was the fourth warmest on record, exceeded by 1998, 2002 and 2003. Fig.1.1 shows the combined global land and marine surface temperature record from 1856 to 2004 (by the Climatic Research Unit and the UK Met. Office Hadley Centre).

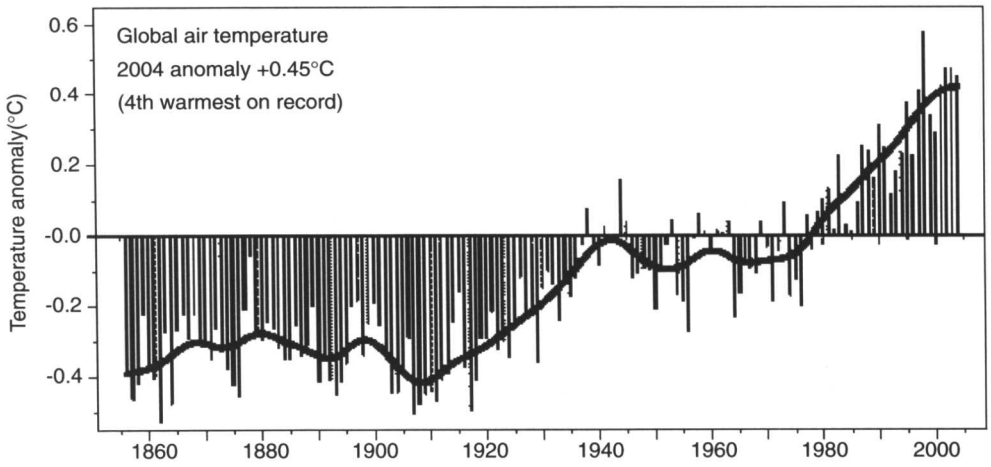


Fig.1.1 Combined global land and marine surface temperature (source: Climate Research Unit, UK)

Warming is evident in both sea surface and land surface air temperatures. Urbanization in general and desertification could have contributed only a small fraction to overall global warming, although urbanisation may have been an important influence in some regions.

The rise in temperatures has been accompanied by changes in the world around us:

- ice caps are retreating from many mountain peaks like Kilimanjaro;
- global mean sea level rose by an average of 1～2mm a year during the 20th century; summer and autumn arctic sea ice has thinned by 40% in recent decades;
- global snow cover has decreased by 10% since the 1960s;
- El Nino events have become more frequent and intense during the last 20～30 years;
- usage of the Thames Barrier has increased from once every two years in the 1980s to an average six times a year over the past 5 years; and
- weather-related economic losses to communities and businesses have increased ten-fold over the last 40 years.

The Intergovernmental Panel on Climate Change in its most recent report stated:

'Most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations.'

Humanity's greenhouse gas emissions are expected to lead to climatic changes in the 21st century and beyond. These changes will potentially have wide-ranging effects on the natural environment as well as on human societies and economies. Climate change is real. The first challenge we face is environmental. We cannot escape some climate change. But the worst effects can be avoided if greenhouse gases in the atmosphere are stabilised

instead of being allowed to go on increasing. Levels of carbon dioxide (CO_2) in the atmosphere, one of the main causes of climate change, have risen by more than a third since the industrial revolution and are now rising faster than ever before. Climate induced environmental changes cannot be reversed quickly, even if the anthropogenic emissions of CO_2 are stabilized or reduced, the CO_2 content in the atmosphere will still increase for some time. Global warming cannot be solved by a single nation alone and needs to be tackled internationally.

1.1.1 Action on carbon emission reduction

An agreement on global warming was reached by the United Nations Conference on Climate Change in Kyoto, Japan, in 1997. The major industrial nations pledged to reduce their emissions of greenhouse gases between 2008 and 2012. A general framework was defined for this, with specifics to be detailed over the next few years. This became known as the Kyoto Protocol. 141 countries, accounting for 55% of greenhouse gas emissions, have ratified the treaty, which pledges to cut these emissions by 5.2% by 2012.

The UK Energy White Paper addresses environmental challenges and gives a new direction for energy policy. The UK specified a target of reduction in carbon dioxide emissions of some 60% from current levels by about 2050. China approved the Kyoto Protocol of the United Nations Framework Convention on Climate Change and signed the pact on May 29, 1998. The Chinese government believes that the United Nations Framework Convention on Climate Change and its Kyoto Protocol set forth fundamental principles and provide an effective framework and a series of rules for international cooperation in combating climate change, and as such they deserve worldwide compliance.

1.1.2 Energy and building in China

Fig.1.2 shows CO_2 emissions of selected countries in 1995. China has the second biggest emissions of Greenhouse gas emission in the world. However, per capita the Chinese emissions are very low compared to the no. 1 on the list, the USA.

China has seen a rapid economic growth for much of the past two decades. This growth has had huge implications for energy consumption and the environment. For example, with growing income and affluence, urban households are dramatically increasing their material consumption and demand for energy. The total stock of refrigerators rose from four million in 1985 to 60 million in 1996 and refrigerators now account for half of residential energy

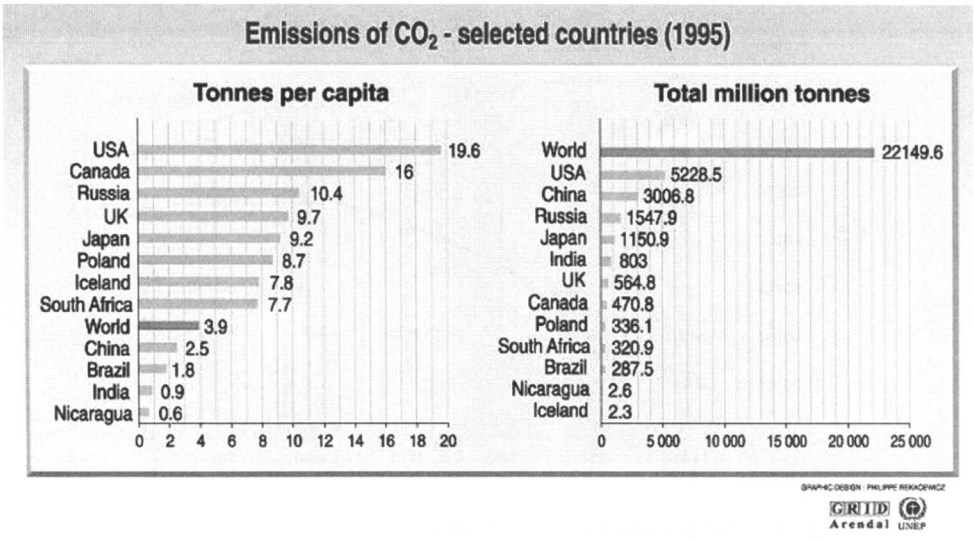


Fig.1.2 CO_2 emissions of selected countries in 1995

consumption. Energy consumption in the residential sector grew by 16 percent annually on average from 1980 to 1994. Air conditioners are now becoming ubiquitous in urban areas as well. Private automobile ownership, at one time illegal, grew to four million in 1996 and is now rising by an estimated one million cars annually. The environmental consequences of this economic growth are staggering, as accelerating air and water pollution threaten public health, damage ecosystems, and add to global climate change.

Building construction is the third largest player in the Chinese economy. The decade 2000～2010 is expected to include a residential construction boom in China. Fig.1.3 shows the trend for building construction. Building energy consumption accounted for about 27.6% of total energy in 2001. It is projected that energy consumption in buildings will increase to 35% in 2020. Fig.1.4 shows building energy consumption in China in 1996～2001. As part of building energy consumption, heating and air conditioning accounts for 65%, heating for water 15%,

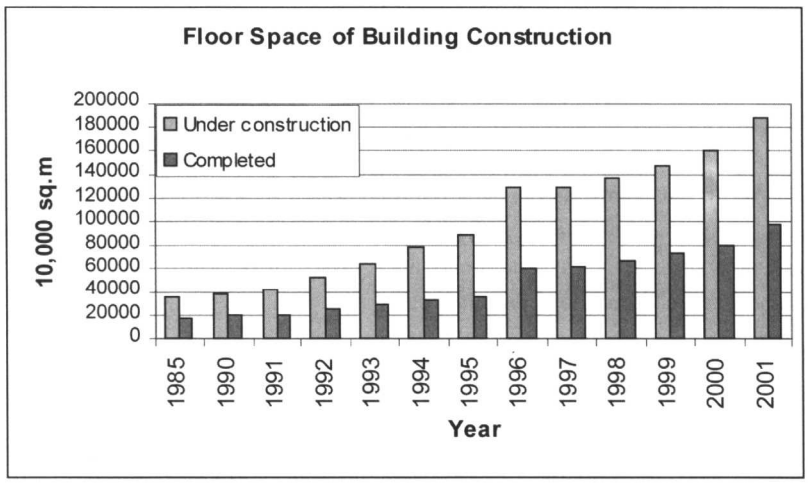
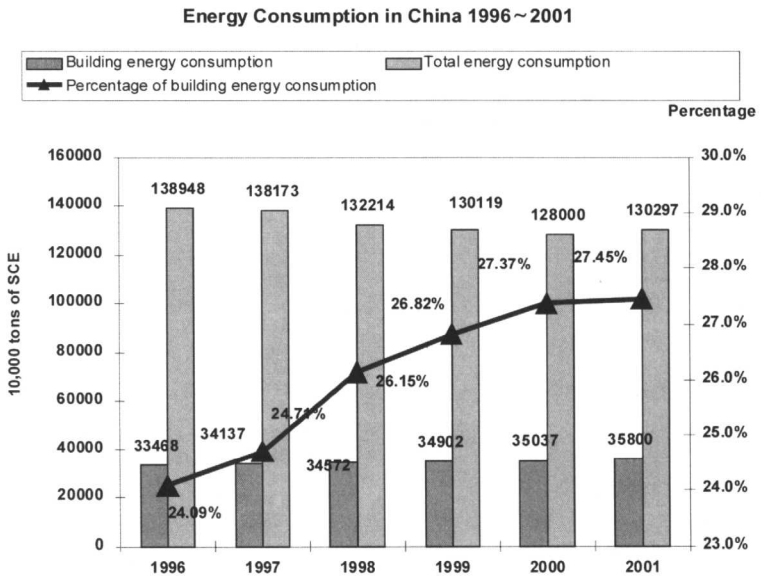


Fig.1.3 Floor space of building construction 1985～2001
Source: Chinese Statistic Yearbook 2002, National Bureau of Statistics



SCE: Standard coal equivalent
Fig.1.4 Building energy consumption 1996～2001
Source: Construction Ministry Energy Conservation Centre

electric lighting 14% and cooking 6%. From these Figures we can see that heating and cooling consume, by far, the most energy. According to national statistics, in 2001 central heating in China was used to heat an area of north China equivalent to 1.46×10^9 square meters. Fig.1.5 shows the area heated in different regions in north China (China Statistic Year Book 2002). Air conditioners are now becoming common in urban areas. Fig.1.6 shows the growth of air conditioner ownership in China.

According to a government survey in 2000, only 5.7% of buildings are designed to the thermal design code. Up to 2001, a total area of existing building is 370 hundred million square metres, of which 110 hundred million square metres is in the urban area. Only 2.3 thousand million square metres are built to the required standard, which accounts for only 2.1% of the urban area. The government encourages the implementation of energy policy in the built environment via various measures.

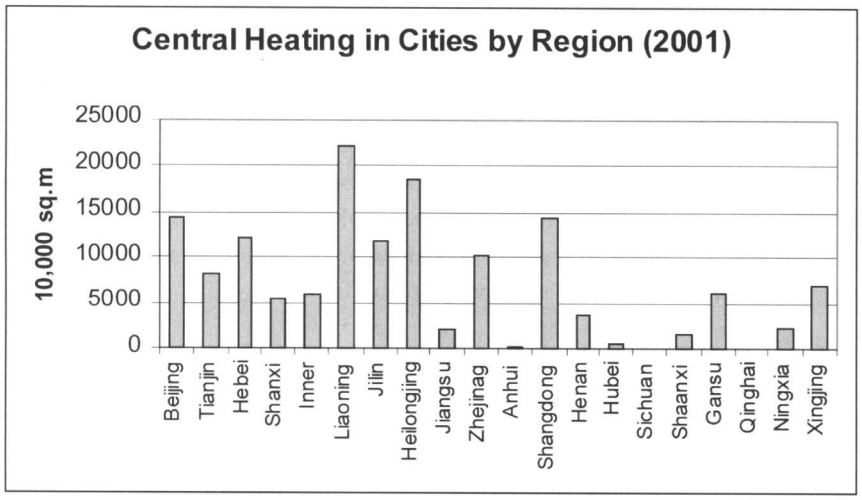


Fig.1.5 Central heating in cities in different regions
Source: Chinese Statistic Yearbook 2002, National Bureau of Statistics

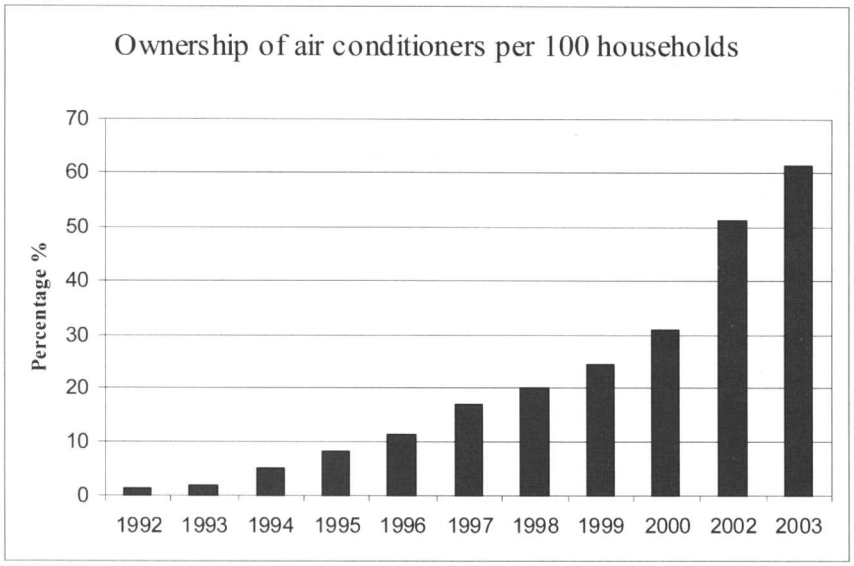


Fig.1.6 Ownership of air conditioners
Source: China Energy Databook and Statistic Book 2002, 2004