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## **ABSTRACT**

### **THE PUBLIC UNDERSTANDING OF CLIMATE CHANGE: A CASE STUDY OF TAIWANESE YOUTH**

**by  
Shih-Yun Kuo**

Global climate change is likely to be the most challenging environmental dilemma of the 21st century because its impacts on ecosystems and human society are transnational in scale and long term in scope. Due to its high scientific complexity and uncertainty and high political and economic sensitivity, mitigating the problem will require interdisciplinary cooperation and collective and sustained efforts on the part of all nations. Sufficient domestic support from both government and the lay public will not only be significant to the success of an international climate regime, but also crucial to the effectiveness of potential domestic climate policies.

Such circumstances call for exploration of how the level of the public's scientific understanding of climate change influences choices for climate protective actions and support for climate policies. Social scientists have the responsibility to explore how people perceive, understand, and respond to global climate change and to investigate the roles and interrelationships of various actors (e.g., scientists, citizens, and elected and appointed officials) in the policy-making process. Compared with numerous social scientific studies of global climate change in North America and Europe, substantially fewer investigations have focused on other regions of the world. Therefore, this doctoral research presents a case study of domestic climate policy formulation premised on the integration of science and citizens in an industrialized Asian society—Taiwan.

This dissertation reports the views of Taiwanese youth with respect to global climate change based on data compiled from three empirical studies (i.e., integrated assessment focus groups, pre- and post-surveys, and a web-based survey). These studies in combination present three primary findings: 1) Most Taiwanese young adults tend to endorse pro-climate protection attitudes and behaviors; 2) These young adults display an extensive but limited scientific understanding pertaining to the problem; 3) A process of experimental participation with scientists enhanced individual scientific understanding and policy making.

Further investigation revealed that these perceptions were grounded in a strong sense of ecological citizenship, which is likely influenced by the contemporary environmental movement in Taiwan since the 1980s. While this case study finds that scientific knowledge is less influential in determining individual behavioral intentions than public attitudes toward climate change, the continual enhancement of public ethical awareness about global climate change provides a helpful approach for policy makers seeking to obtain public support.

**THE PUBLIC UNDERSTANDING OF CLIMATE CHANGE:  
A CASE STUDY OF TAIWANESE YOUTH**

**by  
Shih-Yun Kuo**

**A Dissertation  
Submitted to the Faculty of  
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**Department of Chemistry and Environmental Science**

**August 2010**

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**APPROVAL PAGE**

**THE PUBLIC UNDERSTANDING OF CLIMATE CHANGE:  
A CASE STUDY OF TAIWANESE YOUTH**

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When Mr. Bob Sheppard, a well-known announcer for the New York Yankees, presented the performance of *God Bless America* during the seventh inning stretch, he always asked fans to “offer a moment of silent prayer for the service men and women who are stationed around the globe and especially remember those who have lost their lives defending our freedom and our way of life.” Every time I heard his introduction, I asked myself the same questions: What kind of life styles did these honored soldiers sacrifice their lives to defend for us? Vehicles with cheap gasoline, suburban houses with lawns and pools, or so-called American dreams?

Do these pursuits of good living standards merit the sacrifice of thousands of human lives and the destruction of the environment? While American dreams have now become an ultimate goal for people around the world, what would the environment become if everybody on Earth attempted to pursue their American dreams? Perhaps it is time to rethink the way of life we *need*. Perhaps it is time for us to make a decision to sacrifice some of our quality of life and move toward more sustainable lifestyles.

My family has been a great influence on my value system of material pursuits and quality of life, and my viewpoints toward public affairs and environmental matters. Therefore, I would like to dedicate this dissertation to my beloved family. Without their love and unwavering support, this dissertation would not have been possible.

謹將此論文

獻給我最摯愛的家人—

阿公、爸爸、媽媽、哥哥、嫂嫂、庭歡、庭源

感謝你們的支持與鼓勵

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## TABLE OF CONTENTS

<b>Chapter</b>	<b>Page</b>
1 INTRODUCTION .....	1
1.1 Overview .....	1
1.2 Research Overview .....	2
1.2.1 Introduction .....	2
1.2.2 Research Objectives .....	3
1.2.3 Problem Statement .....	4
1.2.4 Research Contribution .....	11
1.2.5 Concluding Remarks .....	12
1.3 Background Context .....	13
1.3.1 Introduction .....	13
1.3.2 Climate Science Background—Causes and Consequences .....	14
1.3.3 International Politics Background—International Climate Treaties ....	25
1.3.4 Concluding Remarks .....	38
1.4 Dissertation Structure .....	39
1.5 Summary .....	39
2 LITERATURE REVIEW .....	42
2.1 Overview .....	42
2.2 Science and Citizens in the Formulation of Environmental Policy .....	43
2.2.1 Introduction .....	43
2.2.2 Policy-making Process for Environmental Problems .....	44

**TABLE OF CONTENTS**  
(Continued)

<b>Chapter</b>	<b>Page</b>
2.2.3 Science and the Policy-making Process .....	53
2.2.4 Citizens and the Policy-making Process .....	59
2.2.5 Public Understanding of Science .....	68
2.2.6 Concluding Remarks .....	83
2.3 Sociological Studies of Climate Change .....	85
2.3.1 Introduction .....	85
2.3.2 Theoretical Relationships of Attitudes, Knowledge, and Behaviors ...	86
2.3.3 Public Perception of Climate Change .....	92
2.3.4 Public Scientific Understanding of Climate Change .....	105
2.3.5 Public Participation in the Development of Climate Policy .....	112
2.3.6 Concluding Remarks .....	124
2.4 Summary .....	125
3 CASE STUDY CONTEXT .....	128
3.1 Overview .....	128
3.2 Study Area—Why Taiwan? .....	129
3.2.1 Introduction .....	129
3.2.2 A Glance of Taiwan .....	130
3.2.3 High Responsibility .....	132
3.2.4 High Vulnerability .....	137
3.2.5 Sociopolitical Condition .....	141

**TABLE OF CONTENTS**  
**(Continued)**

<b>Chapter</b>	<b>Page</b>
3.2.6 Concluding Remarks .....	142
3.3 The Changing Social Values in Taiwan .....	144
3.3.1 Introduction .....	144
3.3.2 Enduring Character or Shifting Values .....	145
3.3.3 Political-cultural Perspective .....	147
3.3.4 Socio-psychological Perspective .....	151
3.3.5 Concluding Remarks .....	154
3.4 Environmental Politics in Taiwan .....	155
3.4.1 Introduction .....	155
3.4.2 Evolution of the Environmental Movement .....	156
3.4.3 The Emergence of Environmental Concern .....	160
3.4.4 Public Perception of Climate Change in Taiwan .....	165
3.4.5 Concluding Remarks .....	170
3.5 Domestic Climate Policies in Taiwan .....	171
3.5.1 Introduction .....	171
3.5.2 The Politics of Global Climate Change in Taiwan .....	172
3.5.3 The Evolution of Climate Policy Making .....	177
3.5.4 Two Domestic Mitigation Policies .....	181
3.5.5 Concluding Remarks .....	185
3.6 Summary .....	186

**TABLE OF CONTENTS**  
**(Continued)**

<b>Chapter</b>	<b>Page</b>
4 RESEARCH METHODS .....	188
4.1 Overview .....	188
4.2 Research Questions, Objectives, and Constituent Studies .....	189
4.3 Study Population .....	191
4.3.1 Introduction .....	191
4.3.2 Why Focuses on Youth? .....	192
4.3.3 Youth in Taiwan .....	197
4.3.4 Concluding Remarks .....	198
4.4 Study 1: IA Focus Group Workshop .....	198
4.4.1 Introduction .....	198
4.4.2 IA Focus Groups .....	199
4.4.3 Procedure and Recruitment .....	201
4.4.4 Moderator and Expert .....	203
4.4.5 Session Design .....	204
4.4.6 Data Analysis .....	207
4.4.7 Concluding Remarks .....	207
4.5 Study 2: Pre- and Post-Survey .....	208
4.5.1 Introduction .....	208
4.5.2 Survey Research Method .....	209
4.5.3 Survey Approach .....	210

**TABLE OF CONTENTS**  
**(Continued)**

<b>Chapter</b>	<b>Page</b>
4.5.4 Administration .....	212
4.5.5 Questionnaire Design .....	213
4.5.6 Data Analysis .....	221
4.5.7 Concluding Remarks .....	222
4.6 Study 3: Web-based Survey .....	223
4.6.1 Introduction .....	223
4.6.2 Internet-assisted Survey .....	224
4.6.3 Administration .....	229
4.6.4 Sampling .....	230
4.6.5 Questionnaire Design .....	232
4.6.6 Data Analysis .....	237
4.6.7 Concluding Remarks .....	237
4.7 Summary .....	238
5 RESULT AND ANALYSIS .....	240
5.1 Overview .....	240
5.2 Research Results .....	241
5.2.1 Introduction .....	241
5.2.2 Study 1: IA Focus-Group Workshop .....	242
5.2.3 Study 2: Pre- and Post-Survey .....	257
5.2.4 Study 3: Web-based Survey .....	274

**TABLE OF CONTENTS**  
**(Continued)**

<b>Chapter</b>	<b>Page</b>
5.2.5 Concluding Remarks .....	292
5.3 Analysis: Constituent Elements and the Relationships .....	293
5.3.1 Introduction .....	293
5.3.2 Attitudes .....	294
5.3.3 Scientific Knowledge .....	300
5.3.4 Behavioral Intentions .....	302
5.3.5 Relationships among Constituent Elements .....	305
5.3.6 Effectiveness of the IA Focus Groups .....	309
5.3.7 Concluding Remarks .....	312
5.4 Summary .....	313
6 DISCUSSION AND CONCLUSION .....	316
6.1 Overview .....	316
6.2 Discussion .....	317
6.2.1 Introduction .....	317
6.2.2 Ecological Citizenship in Taiwanese Youth .....	318
6.2.3 Scientists, Citizens, and Policy Making .....	324
6.2.4 Concluding Remarks .....	330
6.3 Conclusion .....	331
6.3.1 Introduction .....	331
6.3.2 Summary of Findings .....	332

**TABLE OF CONTENTS**  
**(Continued)**

<b>Chapter</b>	<b>Page</b>
6.3.3 Contributions of this Research .....	334
6.3.4 Directions for Further Research .....	336
6.3.5 Concluding Remarks .....	338
6.4 Summary .....	339
APPENDIX A SURVEY INSTRUMENT FOR THE PRE- AND POST-SURVEY (ENGLISH).....	341
APPENDIX B SURVEY INSTRUMENT AND FREQUENCY DISTRIBUTION FOR THE WEB-BASED SURVEY (ENGLISH).....	349
REFERENCES .....	354

## LIST OF TABLES

<b>Table</b>	<b>Page</b>
1.1 Major Achievement of Conferences of the Parties (COP) During 1995-2009 .....	27
1.2 The Stages and Obstacles of Climate Cooperation .....	34
2.1 Public Participation Methods .....	64
2.2 The Development of Public Understanding of Science Research .....	70
2.3 Public Perception of Barriers to Engaging with Climate Change .....	102
2.4 Socio-psychological Denial and Displacement Mechanisms .....	121
3.1 Taiwan’s Energy/Economy/Environmental Indicators in 2007 .....	136
3.2 The Political Transformation History of Taiwan .....	148
3.3 Questions and Responses of Viewpoints about Political Participation .....	152
3.4 The Frequency Distribution of Attitudes toward Political Participation (1984-2005) (n range from 1895 to 4199) .....	153
3.5 The Frequency Distribution of Attitudes toward Political Participation in 2008 (n=1980) .....	154
3.6 Public Concern about Environmental Quality in the Past and Future .....	162
3.7 Environmental Consciousness—the Relationship between Environment and Development Index (1983-1999) .....	163
3.8 The Frequency Distribution of Agreements with Pro-environmental Attitudes .....	165
3.9 The Frequency Distribution of Two Climate-Related Knowledge Questions .....	167
3.10 Policy Discourse Analysis in Different Periods from 1992 to 2008 .....	178
3.11 Policy Discourse Analysis in Different Periods from 1992 to 2008 (Conti.) .....	179
3.12 Energy Conservation and Carbon Reduction Declaration .....	184
4.1 Secondary Research Questions and Objectives .....	189

**LIST OF TABLES**  
(Continued)

<b>Table</b>	<b>Page</b>
4.2	Agenda and Session Description of the IA Focus-Group Workshop ..... 204
4.3	Comparison of the Two Approaches of Environmental Concern ..... 212
4.4	Dimension, Variable, and Question Number of Section I (General Concern) ..... 215
4.5	Dimension, Variable, and Question Number of Section II (Scientific Knowledge) ..... 217
4.6	Dimension, Variable, and Question Number of Section III (Individual Responses) ..... 220
4.7	Comparison of Advantages and Disadvantages of Different Survey Methods ..... 225
4.8	Internet Usage in Users and Penetration in Regions in 2009 ..... 226
4.9	World Ranking of Internet Penetration in Selected Countries ..... 227
4.10	Items of Scientific Knowledge and Variable in the Online Survey ..... 235
5.1	Pre- and Post-Scores of on the Scientific Knowledge Section (n=18) ..... 265
5.2	Percentage of the Respondents Answer Correctly in Each Item in the Pre- and Post-Surveys (n=18) ..... 267
5.3	Response Count and Frequency of Key Characteristics of the Respondents (n=285) ..... 276
5.4	Percentage Distribution and Rating Average of the Personal Relevancy Index (n=285) ..... 283
5.5	Percentage Distribution of the Scientific Understanding Index (n=285) ... 285
5.6	Percentage Distribution and Rating Average of the Personal Behavior Index (n=285) ..... 289
5.7	Percentage Distribution and Rating Average of the Policy Preferences Index (n=285) ..... 291
5.8	Pearson Correlations and P Value for Numerous Variables (n=285) ..... 307

## LIST OF FIGURES

Figure		Page
1.1	Carbon dioxide emissions from fuel combustion in selected countries during the period 1971-2007 (IEA, 2009) .....	6
1.2	Changes in atmospheric concentrations of carbon dioxide, methane and nitrous oxide from glacial and interglacial ice core data (IPCC, 2007a) .....	17
2.1	The policy-making process in the policy-cycle model with different stages .....	49
2.2	The attitude-behavior theory and the expressions of attitudes .....	87
2.3	Patchen's model of the determinants of behavior relevant to climate change .....	88
2.4	The three phases of IA focus-group processes (Kasimir et al., 2003) .....	117
3.1	The geographic location of Taiwan .....	130
3.2	The percentage of six major greenhouse gasses in the total GHG emissions of Taiwan in 2007 (316 Mt CO <sub>2</sub> eq.) .....	132
3.3	Carbon dioxide emissions from fuel combustion in Taiwan during the period 1971-2007 (IEA, 2009) .....	133
3.4	Carbon dioxide emission distribution (including electricity consumption) by main sectors in Taiwan in 2007 (TBOEMEA, 2009) .....	134
3.5	Carbon dioxide emission coefficient and intensity among selected major countries in 2007 (IEA, 2009) .....	137
3.6	Structure of the draft GHG Reduction Bill (Huang & Lee, 2009) .....	182
4.1	The research structure with the primary and the secondary questions .....	190
4.2	The structure of the pre-and post-survey instrument in sections and dimensions .....	214
4.3	Internet penetrations in selected countries .....	228
4.4	Internet penetrations of different age groups in Taiwan .....	228
4.5	The execution process and the schedule for the Web-based survey study from preparation, pre test, revision, administration, and analysis .....	229

**LIST OF FIGURES**  
(Continued)

<b>Figure</b>		<b>Page</b>
5.1	Difference of the percentage of the respondents supporting for the prioritized issues in the pre- and post-surveys in Taiwan (n=18) .....	261
5.2	The difference of the level of correct scientific knowledge and uncertainty in the pre- and post-surveys (n=18) .....	269
5.3	The difference of the level of support for various climate policies in the pre- and post-surveys (n=18) .....	273
5.4	Percentage distribution of problem recognition (n=285) .....	277
5.5	Frequency of prioritized public policies in Taiwan (n=285) .....	278
5.6	Frequency of prioritized environmental policies in Taiwan (n=285) .....	278
5.7	Percentage distribution of the top trusting source of information (n=285) .	280
5.8	Percentage distribution of the economy-environment tradeoff (n=285) .....	282
5.9	Distribution of performance in Scientific Understanding Index (n=285) ...	287
5.10	Percentage distribution of reasons to reduce GHG emissions in Taiwan (n=282) .....	288
5.11	Relationships between variables of three constituent elements. Solid lines indicate a good correlation and dash lines indicate a weak correlation .....	308

## LIST OF ACRONYMS

AAU	Assigned Amount Units
ANOVA	Univariate Analyses of Variance
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CLEAR	Climate and Environment in Alpine Regions
CO <sub>2</sub> -eq.	Carbon Dioxide equivalents
COP	Conferences of the Parties
DPP	Democratic Progressive Party
GDP	Gross Domestic Product
EIT	Economies in Transition
ERU	Emission Reduction Units
ET	Emissions Trading
EU	European Union
GHG	Greenhouse Gas
IA	Integrated Assessment
IPCC	Intergovernmental Panel on Climate Change
IRB	Institutional Review Board
JI	Joint Implementation
KMT	Kuomintang
MEA	Ministry of Economic Affairs
NJIT	New Jersey Institute of Technology
NTU	National Taiwan University

**LIST OF ACRONYMS**  
**(Continued)**

OECD	Organization for Economic Cooperation and Development
PBI	Personal Behavior Index
PIA	Participatory Integrated Assessment
PPI	Policy Preferences Index
PRI	Personal Relevancy Index
TARGETS	Tool for Analysing Regional and Global Environmental and Health Targets for Sustainability
TEPA	Taiwan Environmental Protection Administration
TSCS	Taiwan Social Change Survey
ULYSSES	Urban Lifestyles, Sustainability, and Integrated Environmental Assessment
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
ROC	Republic of China (Taiwan)

# CHAPTER 1

## INTRODUCTION

### 1.1 Overview

Global climate change may be the most pressing environmental problem of the 21st century because its impacts on ecosystems and human society are transnational in scale and long term in scope.<sup>1</sup> It is an issue not only of scientific debate, but one that also involves political negotiation, economic development, and societal welfare. In addition, this dilemma is relevant to every person on the planet in terms of anthropogenic causes, potential impacts on communities, and necessary mitigation and adaptation strategies. Therefore, this doctoral research, titled *The Public Understanding of Climate Change: A Case Study of Taiwanese Youth*, explores the relationships among science, the public, and politics through an empirical investigation.

This chapter highlights general concepts of this doctoral research. Section 1.2 begins with a brief introduction of the objectives, the problem that is addressed, and the expected contributions of the investigation. Section 1.3 reviews the evolution of global climate change over the past few decades both in terms of scientific understanding and political developments. Section 1.4 describes the overall organization of the dissertation and Section 1.5 summarizes this chapter.

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<sup>1</sup> The definition of global climate change in this dissertation adopts the usage from the Intergovernmental Panel on Climate Change. It refers to any change in climate over time whether due to natural variability or as a result of human activity. Global climate change is often shortened as “climate change,” and is often interchangeably used by the term “global warming.”

## 1.2 Research Overview

### 1.2.1 Introduction

Global climate change has several characteristics that make the issue very difficult for policy makers to manage (e.g., scientific complexity and uncertainty, and temporal and spatial variability) (Carter, 2001). Mitigating the problem will require multidisciplinary cooperation and collective and sustained effort on the part of all nations. In addition, how lay people recognize and attempt to resolve the complex scientific-political problem is an interesting social scientific subject. Therefore, it is particularly important for social scientists to gather knowledge through the initiation of case studies at a local level and to share the findings at a global level.

The research examines and analyzes the public's understanding of global climate change for a specific group (i.e., Taiwanese youth). The study location and study population were selected for consideration because of several advantages to the case study. The investigation comprises three interrelated constituent studies (i.e., an Integrated Assessment (IA) focus-group workshop, a comparative survey, and a web-based survey). The field work was conducted in the summer and fall of 2008 and involved the participation of 303 Taiwanese young adults.

This section provides a brief introduction to this doctoral research. Subsection 1.2.2 describes research objectives of this inquiry. Subsection 1.2.3 explicates the key research problem and the contemporary research gap that this project attempts to address in studying and resolving climate change. Subsection 1.2.4 explains the significance of this case study and highlights a variety of fields to which this research expects to contribute. Subsection 1.2.5 concludes this introductory section.

### 1.2.2 Research Objectives

Global climate change is a scientifically complex problem where the identification of issues (i.e., collecting scientific evidence) and the formulation of interventions (i.e., implementing political actions) involve a wide range of academic disciplines including physical science domains (e.g., atmospheric and meteorological science, marine science, and environmental science) and social science specializations (e.g., economics, politics, and sociology). It appears evident that to effectively mitigate the problem will require intense and protracted interdisciplinary cooperation. However, difficult questions exist regarding the appropriate degree of urgency to attach to the challenges of a changing climate and how best to implement strategies to address them.

While climate change poses questions pertaining to the human dimensions of environmental issues in terms of anthropogenic forces, potential impacts on humans, and necessary individual and political mitigation and adaptation strategies, it is a profound challenge for social scientists to understand how human society is thinking about and reacting to this dilemma. Moreover, it is interesting to explore how various societal actors (e.g., scientists, policy makers, and the public) interact and cooperate with each other. Under such circumstances, the ultimate objective of this dissertation is to present a case study of domestic climate policy making in an industrialized Asian society and the role that public understanding plays in the process. It also includes three supplementary goals:

- To examine the concerns of Taiwanese youth about global climate change in terms of their attitudes, scientific knowledge, and behavioral intentions.
- To investigate the interrelationships among these three elements (i.e., attitudes, scientific knowledge, and behavioral intentions).
- To assess the effectiveness of an experimental participatory exercise (i.e., the IA focus groups) in enhancing individual scientific understanding and engagement in policy making.

### 1.2.3 Problem Statement

Global climate change refers to long-term changes in the planetary climate system (e.g., temperature, precipitation) whether due to natural causes (e.g., alterations in patterns of solar radiation) or human forces (e.g., excessive human-made greenhouse gas (GHG) emissions). While the greenhouse effect is a well established natural phenomenon that maintains the Earth's average surface temperature within a relatively comfortable range, increasing scientific evidence over recent decades has indicated that human beings have significantly altered the climate since the Industrial Revolution (IPCC, 2007a).

The problem poses profound challenges for policy makers because it embodies several typical characteristics of environmental problems (e.g., scientific complexity and uncertainty, temporal and spatial variability) (Carter, 2001). To place an environmental problem on the political agenda, the foremost process is to ensure the scientific validation of claims by collecting sufficient scientific evidence (Hannigan, 1995). Assessment of global warming from human emissions of carbon dioxide (CO<sub>2</sub>) was first published by Nobel laureate Svante Arrhenius (1896) in the late 19th century, but it was not until the 1960s that long-term testing of the theory of global warming began.

Charles Keeling (1961) began to document atmospheric CO<sub>2</sub> concentrations on Mauna Loa in Hawaii in 1957 and he soon found seasonal fluctuations and an annual rise of atmospheric CO<sub>2</sub> concentrations. In addition, the Earth's surface temperatures and atmospheric chemical compositions back to one million years ago were reenacted through advanced technology (e.g., isotopic measurement) to derive information from deep-sea sediment cores and bubbles sealed in ice cores (IPCC, 2007a) (see Section 1.3 for a detailed introduction of the science of climate change).

After several decades of accumulating scientific evidence, the focus of the global climate change policy debate began to shift from scientific risk assessment to political responses (e.g., establishing an international policy framework with national targets and timetables) in the late 1980s (Hempel, 2003).<sup>2</sup> Two important international agreements, the United Nations Framework Convention on Climate Change (UNFCCC) and its subsidiary Kyoto Protocol, were agreed to during the 1990s as initial steps in trying to address the problem by setting national targets and timetables (see Section 1.3 for a detailed introduction of the politics of climate change).<sup>3</sup>

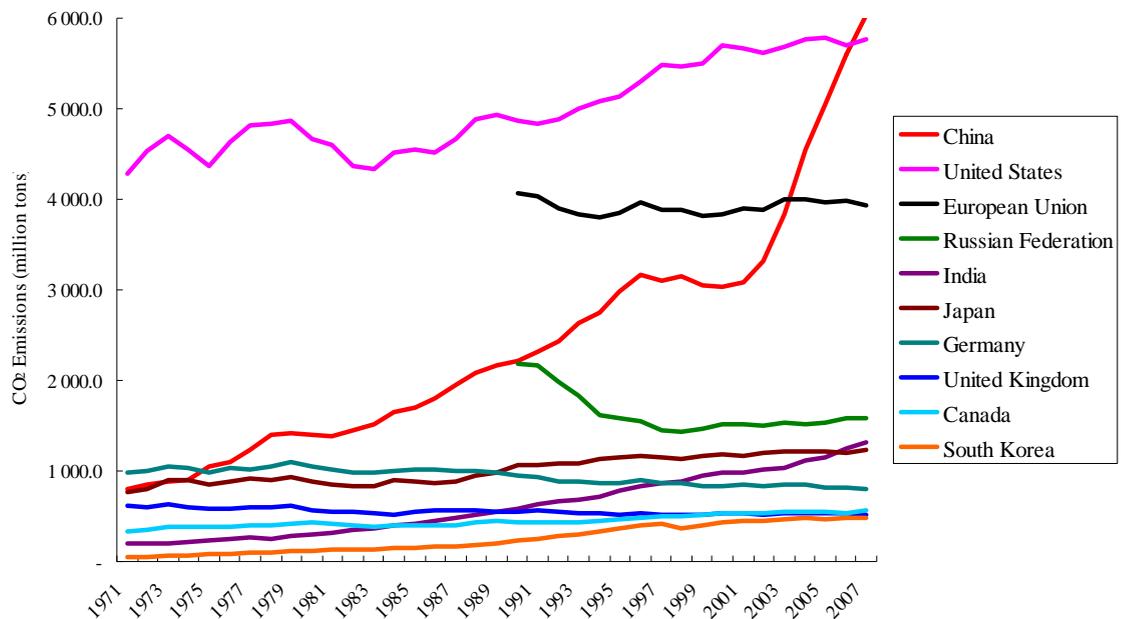
The UNFCCC required participating countries to voluntarily reduce their GHG emissions (without specific targets and timetables) and the Kyoto Protocol further targeted industrialized countries (Annex I Parties) to reduce their GHG emissions (by an average 5.2% below their 1990 levels between 2008 and 2012). According to the report on national GHG inventories (UNFCCC, 2009a), between 1990 and 2007 Annex I Parties with economies in transition (EIT) effectively decreased the total aggregate GHG emissions excluding emissions/removal from land use, land-use change and forestry by 37.0%. In contrast, Annex I non-EIT Parties increased their GHG emissions by 11.2% in the same period (UNFCCC, 2009a).

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<sup>2</sup> Hempel (2003) divided the evolution of climate issues and policies into five stages: 1) scientific assessment (1950s-1988); 2) agenda setting (1988-1992); 3) policy frameworks (1992-1997); 4) national targets and timetables (1997-2012); and 5) contingent implementation (early to mid 21st century).

<sup>3</sup> The UNFCCC, drafted under the auspices of the United Nations, was signed by 154 countries in 1992 at the Earth Summit in Rio de Janeiro. It represented the commitment and cooperation of participating states to resolve the problem of global climate change. The Kyoto Protocol, finalized in 1997, is an international agreement establishing mandatory national targets and timetables to reduce GHG emissions. A total of 183 countries have ratified the Protocol as of January 2009.

The trend in CO<sub>2</sub> emissions of the top ten emitters during the period 1971-2007 displayed in Figure 1.1 reveals that many European countries and the Russian Federation have begun to stabilize or even reduce their CO<sub>2</sub> emissions (IEA, 2009). However, the CO<sub>2</sub> emissions of the United States (US) and developing countries such as China and India continue to grow. In addition, global CO<sub>2</sub> emissions from fuel combustion have doubled from 14,095 million tons (Mt) in 1971 to 28,962 Mt in 2007 (IEA, 2009). Although at one time many observers thought that political recognition of the problem of climate change represented an important landmark, few meaningful results have to date been achieved to reduce GHG emissions in countries other than European Union (EU) members and EIT countries (IEA, 2009; UNFCCC, 2009a).<sup>4</sup>



**Figure 1.1** Carbon dioxide emissions from fuel combustion in selected countries during the period 1971-2007 (IEA, 2009).

<sup>4</sup> Although the effectiveness of the Kyoto Protocol can not be evaluated until the expiring year—2012, the continual increase of global GHG emissions to date has implied the inefficacy of the voluntary-basis of the UNFCCC.

One hundred years after the first scientific publication regarding the anthropogenic greenhouse effect and ten years after the Kyoto Protocol, the atmospheric concentration of human-produced GHGs is still growing, the average global temperature continues to increase, and the magnitude of extreme weather events appears to be intensifying (IPCC, 2007a; Webster et al., 2005). There is apparently a gap between the commitments made by government representatives to international climate treaties in the top-down international political negotiation process and the actual compliance of nations.

Thompson (2006) argues that one of the key political obstacles affecting success of international cooperation in the process of negotiation, ratification, and implementation of GHG mitigation measures is insufficient domestic support from individual nations. On the basis of a comparison of the US and the EU in implementing the Kyoto Protocol (i.e., the US withdrew from the accord and the EU led the deliberations), Vogler and Bretherton (2006) argue that the fundamental difference of the two parties (i.e., US and EU) hinges on the different ways they interpret scientific uncertainty and gauge the urgency of the problem—major European countries for the most part consider global climate change to be real and to require immediate remedial action while this to date has not been the case in the US.

Based on the example of these two actors in international climate politics, a number of questions can be raised to examine several aspects through which a nation gives credence to the problem. Does a country, in terms of the government and citizens in the society, consider climate change to be a pressing and prioritized problem (i.e., problem recognition and political priority)? Does a country identify this issue as its responsibility, especially for major contributors of GHG emissions (i.e., blame and

responsibility)? Is a country aware of the impacts of climate change, especially for populations located in relatively vulnerable areas (i.e., risk perception)? Therefore, it is important for social scientists to investigate how different nations, societies, and cultures are responding to this global challenge by formulating case studies.

In addition, improved scientific understanding over the course of the past decades has led to a consensus that human activities are very likely the significant driving causes that are inducing and accelerating transformations of the climate system and that these changes may have substantial impacts on socio-cultural systems (Kerr, 2001; Oreskes, 2004; IPCC, 2007a). While scientists and environmental advocates continually issue warnings about the upcoming climate crisis in both the popular literature and the media (e.g., Gelbspan, 1998, 2004; Leggett, 2001; Gore, 2006, 2009), institutional responses and political actions—at least thus far—do not seem to correspond with the current view in the scientific community.

Other than an objective scientific construction of knowledge of global warming, many scholars have discussed the need to consider other factors involved in the process of constructing scientific knowledge. For example, Von Storch (2009) proposes the cultural factor and Demeritt (2001) argues for the need to examine social and political relations (e.g., trust in knowledge and the experts systems that produce it). Sarewitz (2004) further asserts that it is unlikely that science on its own can play an effective role in resolving the issue. In the case of global climate change—a scientifically and politically complex dilemma, mutual cooperation between science and politics perhaps provides a more effective approach. As a result, social science research should play a more assertive role in helping to integrate these two domains.

Moreover, even if a wide array of energy-efficient products were to be designed to reduce CO<sub>2</sub> emissions (e.g., hybrid electric vehicles) and even if the efficacy of a GHG reduction policy could be expected, the ultimate goal of stabilizing atmospheric GHG concentrations will never be achieved if individuals, societies, and governments do not choose to take actions to modify behaviors. So the big mystery remains to be solved: Why would individuals and societies be willing or reluctant to take actions to mitigate the problem? It appears that the answer to global climate change is beyond a simple technological fix or a political solution. Thus, social scientists can likely help to bridge the different appraisals of laypeople and the scientific and political communities.

The prospect above suggests that an important task for social scientists is to study the human dimensions of climate change and to try to understand how human beings (at both a micro-individual level and a macro-societal level) perceive, respond, and expect to resolve such a complex global environmental problem. Gore (2009) argues that it is naïve for human society to place the burden of solution on individuals alone (i.e., to change lifestyle choices) and that it is increasingly important to take further aggressive actions on different societal levels (i.e., to change laws and policies). Moreover, individuals' actions are not limited to purely personal responses (e.g., changing light bulbs); they can become active participants in the political process.

Therefore, there are two questions of prominent interest with respect to social scientific research with respect to climate change. The first question centers on the factors that drive public recognition and understanding of the issue and the extent to which ordinary people need to possess scientific knowledge to gain an appreciation of it at an individual level. The second question centers on the dynamic interaction between science

and the public and how scientific experts communicate global climate change to lay audiences. In short, does scientific understanding of climate change enhance public willingness to change behavior and to endorse potentially stringent climate policies? Can public involvement in the policy-making process with the integration of scientific expertise contribute to the development of more effective climate-protection actions?

It seems apparent that collective efforts from all over the world are essential to successfully accomplish a global goal. However, compared with numerous social scientific studies of global climate change in North America and Europe, substantially fewer investigations have focused on other regions of the world. As the focus of mitigation responsibility begins to shift to developing countries in the post-Kyoto period, it has become increasingly important to expand this work to include geographic areas other than North America and Europe, especially fast growing Asian economies.

Taiwan is a newly-industrialized society with high mitigation responsibility and high vulnerability to global climate change. Even though Taiwan is not a signatory to the UNFCCC and the Kyoto Protocol—thus not obligated to fulfill a GHG mitigation responsibility, it is interesting to find that the Taiwanese government has actively initiated a series of political responses since 1992. What factors trigger the Taiwanese government to take actions to address global climate change? How do Taiwanese people think of this challenge? How do scientists interact with the public in the process of communicating this scientifically complex problem? Therefore, this research aims to explore these questions by presenting a case study of the public understanding of climate change in Taiwan (see Chapter 3 for a detailed introduction of the context of this case study).

#### 1.2.4 Research Contribution

This doctoral research is expected to make several contributions. First, compared with numerous social scientific studies of global climate change in North America and Europe, substantially fewer investigations have focused on other regions of the world. As the focus of mitigation responsibility begins to shift to developing countries in the post-Kyoto period, it has become increasingly important to expand this work to include geographic areas other than North America and Europe. Thus, a case study of Taiwan is beneficial in presenting an Asian perspective.

Second, Taiwan serves as the case study for this dissertation because of several noteworthy characteristics. It is a newly-industrialized society with a high mitigation responsibility because of its large per capita GHG emissions. In addition, Taiwan is an island with high vulnerability to various adverse impacts of climate change. Furthermore, Taiwan has a newly democratic system of governance that has begun to encourage public engagement in the policy-making process. A case study of Taiwan is advantageous because the results can be compared with studies conducted in other countries that may share similar characteristics (e.g., high responsibility or high vulnerability).

Third, the study population of this research constitutes a specific civil society group—youth (for a detailed discussion see Section 4.3). The perspective of this demographic cohort is significant because young adults are the voices of an insurgent generation that will over time assume greater responsibility for implementing policies congruent with the aims of sustainable development. Moreover, in the process of understanding young people's opinions about climate change and climate policies, the research collects detailed insights and recommendations about the issue. These

observations can be beneficial to policy makers in designing more socially acceptable policies.

Finally, the focus of this dissertation is on Taiwan's multicultural society, one that has been influenced by both traditional Chinese and modern western cultures. This facet of the investigation is expected to bring to the surface the most notable contribution. Given that Taiwan shares a similar ancient culture with China (e.g., Confucianism), this case study can be regarded as an exploratory examination that could be useful for guiding future social science research on the most populous and economically dynamic country in the world.

### **1.2.5 Concluding Remarks**

Due to its scientific complexity and temporal-spatial variability, global climate change is a profound challenge for human beings to confront in the 21st century. Efforts to effectively address the problem require cooperation from a variety of disciplines (e.g., science, politics, economy, and sociology) and collective and sustained effort on the part of all nations. After decades of increasingly more precise scientific validation, the scientific community appears to have reached a consensus about the substantial influence of human activities on the global climate system. However, the political responses at both global and national levels have been insufficient to effectively reduce GHG emissions.

In an effort to increase contemporary understanding of the public-science nexus around global climate change, this doctoral research aims to 1) examine the concerns of Taiwanese youth about global climate change in terms of their attitudes, scientific knowledge, and behavioral intentions; 2) investigate the interrelationships among these three elements (i.e., attitudes, scientific knowledge, and behavioral intention); 3) assess

the effectiveness of an experimental participatory exercise (i.e., the IA focus groups) in enhancing individual scientific understanding and engagement in policy making. The field work for this case study took place in the summer and fall of 2008 and involved the participation of 303 Taiwanese young adults.

This inquiry is expected to provide several contributions. The findings of this case study of Taiwan are advantageous because they present various perspectives for further comparisons: the views of young adults in a newly-industrialized Asian society with high responsibility for and high vulnerability to global climate change. In addition, the experimental focus-group exercise offers beneficial insights to policy makers regarding lay perspectives on the issue. Finally, the similar cultural background makes this case study potentially useful as an exploratory investigation for future social scientific research on the human dimensions of climate change in China.

## **1.3 Background Context**

### **1.3.1 Introduction**

If the greenhouse effect is a natural phenomenon that maintains the Earth's average surface temperature at a level that is fit for human habitation, why would an increasing global average temperature become the most pressing environmental problem in the 21st century? If the scientific community agrees with the significance of anthropogenic influences on the climate system, why have we not seen strong political determination to put forward necessary actions to effectively resolve the problem? The answer to these two questions is relatively straightforward: climate change is a complex issue highly dependent on societal engagement between scientific information and political processes.

Global climate change embodies several characteristics that make it very difficult to manage (e.g., scientific complexity and uncertainty, temporal and spatial variability) (Carter, 2001). In addition, the primary driving force of climate change—excessive GHG emissions due to the fossil-fuel based economy—makes the issue not only one of scientific debate, but of political negotiation, economic development, and societal welfare. To address the problem, many efforts have been made scientifically (i.e., evidence collection and prediction) and politically (i.e., international treaties).

This section introduces the background of the issue of global climate change from the aspects of science and politics. Subsection 1.3.2 explains the science of climate change (i.e., the phenomenon, causes, and consequences) by examining the evolution of key climate-science research. Subsection 1.3.3 describes international political efforts (i.e., international organizations and climate treaties) by reviewing a series of major international climate conferences. Subsection 1.3.4 concludes this section.

### **1.3.2 Climate Science Background—Causes and Consequences**

#### *Climate Change Science Study*

The greenhouse effect is a natural phenomenon in which atmospheric GHGs, such as CO<sub>2</sub> and methane (CH<sub>4</sub>), reabsorb outgoing infrared radiation so that the Earth's average surface temperature is maintained at a relatively comfortable 15 degrees Celsius (°C). This theory was first raised in the nineteenth century by Joseph Fourier (1824) who argued that the Earth would be much colder if it lacked an atmosphere. John Tyndall (1861) later discovered through laboratory experiments that some gases (e.g., H<sub>2</sub>O and CO<sub>2</sub>) might block infrared radiation and that changes in the atmospheric concentrations of these gases could alter the climate.

The average global temperature has followed natural events (e.g., volcanic eruptions<sup>5</sup> and solar flux variations) within a range of natural fluctuations over the past ten centuries. This situation was gradually changed with the onset of the Industrial Revolution (1800-1870) during which fossil fuels came to be used as the primary energy source for production and transportation purposes. Through interrelated processes of population growth, rapid industrialization, and urbanization, massive quantities of CO<sub>2</sub> emissions and large-scale deforestation<sup>6</sup> that have positive radiative forcings<sup>7</sup> have produced an accelerated pattern of increasing atmospheric CO<sub>2</sub> concentrations.

It was not until the late 19th century that the effects of human influence began to draw scientists' attention. Svante Arrhenius (1896) published the first calculation of impacts of human emissions of CO<sub>2</sub>; his work indicated that a 40% increase or decrease of atmospheric CO<sub>2</sub> concentrations might trigger glacial advances or retreats. Callendar (1938) argued that global warming induced by increasing atmospheric CO<sub>2</sub> concentrations and fossil-fuel combustion was underway and that a doubling of CO<sub>2</sub> concentrations might cause an increase in the mean global temperature of 2°C.

Scientific studies designed to enhance understanding of global climate change have become more diverse in recent decades. As part of an effort to assess the carbon cycle (and specifically the atmosphere-ocean exchange of CO<sub>2</sub>), Revell and Suess (1957)

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<sup>5</sup> During volcanic eruptions, ash and sulphur dioxide form sulphate aerosols in the stratosphere, which can cool the global climate.

<sup>6</sup> Due to rapid population growth and urbanization, massive area of forest have been destructed and transformed to agricultural or urban uses, which diminishes the natural capacity to absorb CO<sub>2</sub> in the atmosphere.

<sup>7</sup> Radiative forcing is a measure of the warming or cooling influence a factor has in altering the balance of incoming and outgoing energy in the atmosphere system. Positive forcing tends to warm the surface while negative forcing tends to cool it (IPCC, 2007a).

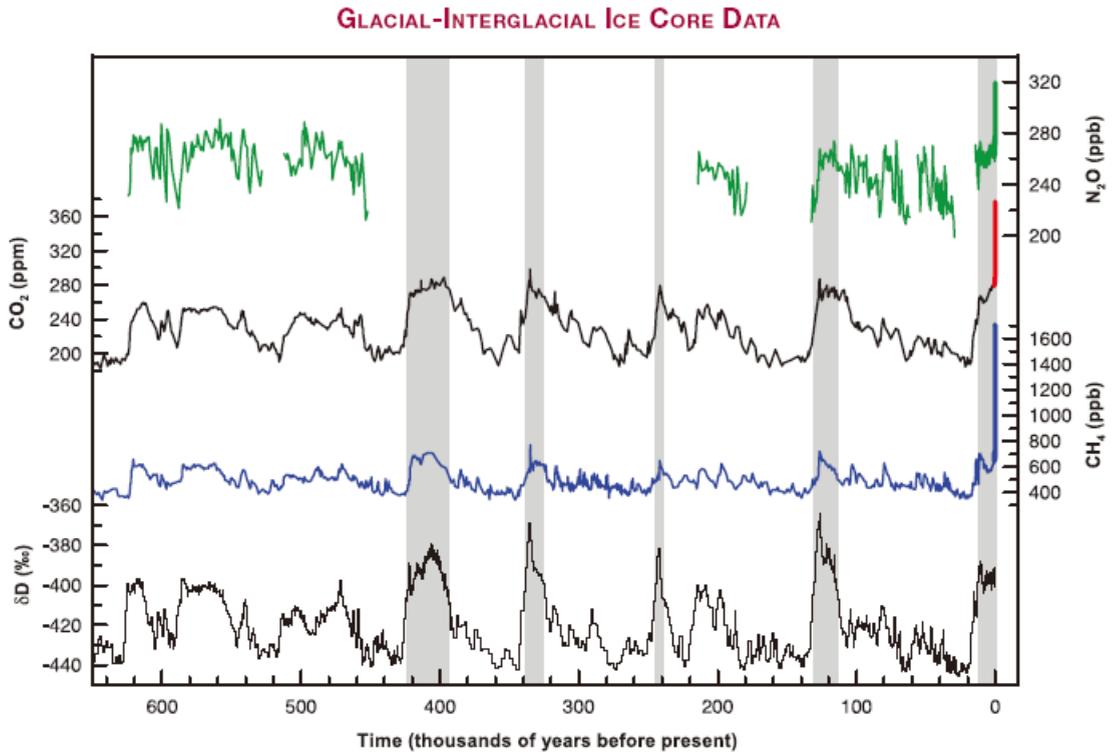
found that it might take centuries for the oceans to completely absorb CO<sub>2</sub> accumulated in the atmosphere. In addition to CO<sub>2</sub> and H<sub>2</sub>O, other anthropogenic GHGs (e.g., CH<sub>4</sub>, nitrous oxide (N<sub>2</sub>O), and chlorofluorocarbons (CFCs)) were recognized in the 1970s (Ramanathan, 1975; Wang et al., 1976). Moreover, scientists identified the cooling effects of atmospheric aerosols (suspended small particles) and clouds by reflecting sunlight (Twomey, 1977; Charlson et al., 1990).

Modern data of atmospheric CO<sub>2</sub> concentrations began to be documented in the late 1950s. By measuring atmospheric CO<sub>2</sub> concentrations at the Mauna Loa observatory in Hawaii, Charles Keeling (1961) observed their seasonal fluctuation due to exchange of CO<sub>2</sub> through photosynthesis and respiration between the atmosphere and biosphere.<sup>8</sup> In addition to the annual cycle, he observed an annual rise of the atmospheric CO<sub>2</sub> concentrations over the course of decades of work (Keeling, 1961).

Despite modern documentation of atmospheric CO<sub>2</sub> concentrations it is necessary to have longer term records of GHGs to prove anthropogenic influences on changes in the composition of the global atmosphere. Using advanced technology (e.g., the isotopic measurement), scientists have been able to reconstruct the Earth's surface temperatures and atmospheric chemical compositions dating back 650,000 years from the bubbles sealed in the polar ice cores (Barnola et al., 1987; IPCC, 2007a). These palaeoclimatic findings reveal that even though the Earth is currently in an interglacial period, the high concentration of atmospheric GHGs and the warmth of the last half century are unusual and beyond natural fluctuations in the Earth's history (IPCC, 2007a) (Figure 1.2).

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<sup>8</sup> When trees in the Northern Hemisphere lose their leaves in winter, the atmospheric CO<sub>2</sub> concentrations increase because of the decreasing capacity of absorbing CO<sub>2</sub>. When the trees grow leaves in the following spring and summer, the atmospheric CO<sub>2</sub> concentrations decrease.



**Figure 1.2** Changes in atmospheric concentrations of carbon dioxide, methane and nitrous oxide from glacial and interglacial ice core data (IPCC, 2007a).

### Intergovernmental Panel on Climate Change (IPCC)

In light of increasing attention regarding climate change in the scientific community, the World Meteorological Organization (WMO) and the United Nations Environmental Program (UNEP) sponsored the first World Climate Conference and established the World Climate Program in 1979 as an initial effort to synchronize international research. This work program led in 1988 to the establishment of the Intergovernmental Panel on Climate Change (IPCC) with the goal of resolving scientific uncertainties by providing objective, balanced, policy-relevant, and internationally coordinated assessments of climate change for policy makers around the world (IPCC, 2004).

The IPCC established three working groups (WGs) to bring together hundreds of scientific experts and government policy makers from around the world and to prepare

periodic assessment reports on the physical science basis of climate change (WG I), adverse impacts and adaptation options (WG II), and mitigation options (WG III) (IPCC, 2004). Four formal comprehensive assessment reports have thus far been released in 1990, 1995, 2001, and 2007 and were produced in a rigorous scientific peer-review process (e.g., compiling hundreds of papers to draft reports, reviewing and commenting from peer experts, and drafting the summary in a plenary meeting).

Many criticisms have been raised regarding the role of the IPCC and the content and the production process of the assessment reports (e.g., the misquotation of the project data on the melting of Himalayan glaciers in the Fourth Assessment Report and the lack of transparency of the reviewers and the review process). Schrope (2001) argues that one primary point of the critiques over the IPCC assessment reports concerns scientific integrity. Because of the intended design (i.e., Summary for Policymakers, SPM) some scientists question whether these reports were produced under conditions of actual scientific consensus or politically compromised consensus.

In addition, the charge has been leveled that many climate scientists hold environmentalist views so they tend to stress the most worrying picture of climate change or to understate scientific uncertainty to spur politicians into action (Schrope, 2001). Several innovative ideas were proposed by five climatologists to reform the organization that included restructuring the IPCC as an independent agency with full-time scientists and producing more frequent assessments (rather than a six-year comprehensive report) (Hulme et al., 2010). Despite these critiques, these IPCC reports have been considered and accepted as the authoritative scientific guide for policy makers (Bolin, 1998; Schrope, 2001).

### Current Observation of Climate Change

According to the most recent IPCC Fourth Assessment Report, the global atmospheric CO<sub>2</sub> concentration has increased from a pre-industrial value of about 280 parts per million (ppm) to 379 ppm in 2005 and to 385 ppm in 2008 (IPCC, 2007a; Keeling et al., 2009). Global CO<sub>2</sub> emissions, the quantity of primary heat-trapping gas derived from fuel combustion, have increased from 14.1 in 1971 to 29.0 gigatons (Gt) in 2007 (IEA, 2009).<sup>9</sup>

Global GHG emissions (both CO<sub>2</sub> and non-CO<sub>2</sub> emissions) have increased from 28.7 to 49.0 Gt of CO<sub>2</sub> equivalents (GtCO<sub>2</sub>-eq) with an increase of 70% between 1970 and 2004 (IPCC, 2007c). In 2004, the major sectors of global GHG emissions included energy supply (26%), industry (19%), forestry (17%), agriculture (14%), transport (13%), residential/commercial (8%), and waste (3%). With current mitigation policies, global GHG emissions are expected to continually increase over the next few decades because of further increments of economic growth and associated fossil-fuel utilization.

In addition to the burning of fossil fuels, another human driver of global climate change is deforestation. The global forest area is 3,952 million hectare (ha) which comprises 30% of the world's land area. These forests act as a terrestrial sink for CO<sub>2</sub> (absorbing 3,300 MtCO<sub>2</sub>/yr for the decade 1993-2003) (IPCC, 2007a). However, forests continued to disappear at a rate of 12.9 million ha/yr between 2000 and 2005—the deforestation rate has though improved from the pace of the 1990s which was 13.1 million ha/yr (IPCC, 2007c).

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<sup>9</sup> The data “global CO<sub>2</sub> emissions from fuel combustion” refers to emissions directly from fossil fuels, which does not include other sources of CO<sub>2</sub> emissions and the effect of forestry and land-use change.

Accumulating evidence indicates that the increasing level of GHGs in the atmosphere has begun to alter the global climate system. The average global temperature rose 0.76°C from 1850-1899 to 2001-2005, and eleven of the last twelve years (1995-2006) ranked among the dozen warmest years in the instrumental record of global surface temperature since 1850 (IPCC, 2007a).

In addition to increased average global air and ocean temperatures, widespread decreases in the expanse of the Earth's surface covered by glaciers and sea ice in both hemispheres have contributed to sea-level rise (Oerlemans, 2005). Global average sea level rose at a rate of 3.1 millimeters (mm) per year between 1993 and 2003, which is faster than the rate between 1961 and 2003 when the average was 1.8 mm per year. The total sea-level rise in the 20th century was approximately 0.17 meters (IPCC, 2007a).

Webster et al. (2005) found that due to increasing sea-surface temperatures and saturation vapor pressure, over the past 35 years both the number and the duration of cyclones have decreased, but the number and proportion of tropical cyclones with categories 4 and 5 (wind speed in excess of 56 meter per second or m/s) have increased in basins such as the North Pacific, Indian, and Southwest Pacific Oceans. In other words, although there were fewer tropical storms and storm days, the ones that formed appear to have been stronger and more destructive.

Based on these observations, the current scientific consensus is that the observed increase in average global temperature since the mid-20th century is very likely (above 90% probability) due to increased atmospheric concentrations of anthropogenic GHG stemming from fossil-fuel use, land-use changes, and agriculture (Kerr, 2001; Oreskes, 2004; IPCC, 2007a).

Moreover, numerous observed long-term changes in the regional and local climate system—such as increased frequencies and magnitudes of extreme weather events (e.g., heat waves, floods, and droughts), widespread changes in precipitation volumes, and heightened intensities of tropical cyclones—can be interpreted as signals that global climate change is occurring (IPCC, 2007a). These changes have had discernible impacts on many physical and biological systems at local levels (IPCC, 2007b).

### *Future Projection of Climate Change and Potential Impacts*

Scientists use computer models to estimate future changes in climate with a range of emission scenarios (e.g., from high emission scenarios predicated on a continued fossil-intensive energy path to low emission scenarios based on clean and resource-efficient technologies). IPCC (2007a) found that a further warming of about 0.2°C per decade is projected under these ranges of emission scenarios. The organization also found that even if humans were to keep atmospheric GHG concentrations and aerosols at year 2000 levels, a further warming of 0.1°C per decade could still be expected (IPCC, 2007a).

In addition, projection of global surface warming and sea-level rise at the end of the 21st century shows that the Earth would be 0.6°C warmer (likely range is 0.3-0.9°C) if the atmospheric GHG concentrations and aerosols are constant at year 2000 levels. The low emission scenario projects that the Earth is estimated to be 1.8°C warmer (likely range is 1.1-2.9°C) and sea-level rise is predicted to be 0.18-0.38 meters. However, if humans continue the highest emission scenario, the global average surface temperature is forecast to be 4.0°C warmer (likely range is 2.4-6.4°C) and sea level is predicted to be 0.26-0.59 meters higher at the end of the 21st century (IPCC, 2007a).

The changes in temperature and precipitation patterns are expected to affect each geographic region differently in many aspects including water resources, ecosystems, agriculture and food products, coasts, and public health. In general, drought areas will likely become more extensive and the increasing frequency of heavy precipitation events will probably amplify flood risks. Moreover, if the Earth is 1.5-2.5°C warmer, major ecosystemic changes (e.g., natural habitats and ecological interactions among species) would likely endanger approximately 20-30% plant and animal species (IPCC, 2007b).

In addition, food production is projected to expand at mid- to high latitudes for local average temperature increases of up to 1-3°C and decrease at lower latitude regions. However, the increasing frequency and intensity of droughts and floods are expected to decrease local crop production. Coasts are expected to be at increasing risk of flooding because of sea-level rise especially in densely-populated and low-lying areas in Asia, Africa, and small islands. Finally, climate change is predicted to trigger some health impacts, including increased deaths due to heat waves, floods and storms, and increased diarrhoeal diseases and infectious disease vectors (IPCC, 2007b).

### *Scientific Uncertainty*

Schneider (1989) discussed a number of scientific uncertainties in determining the present and future effects of anthropogenic climate change. First, projecting future CO<sub>2</sub> emissions (i.e., use of fossil fuels and deforestation) requires that social scientists assume behavioral patterns with indecisive parameters such as the size of human population, the per capita consumption of fossil fuels, the development and diffusion of energy efficient technologies, and so forth (Schneider, 1989).

Second, with different CO<sub>2</sub> emission projections in various social and economic scenarios, scientists need to predict atmospheric CO<sub>2</sub> concentrations by considering the interacting biogeochemical process (i.e., carbon cycle and carbon sinks of oceans and forests).

Third, it is very difficult to estimate climate response due to feedback mechanisms (e.g., ice surface, clouds, and water vapor). For example, changes in ice surface may interactively change the Earth's ability to absorb and reflect solar radiation (the albedo effect)—decreasing ice surface may create a darker planet that would absorb more energy—which would in turn amplify the warming (Schneider, 1989).

Fourth, despite the development of global climate models, considerable uncertainty remains over the probability of what and when adverse impacts (e.g., water supplies and extreme weather events) would occur at regional and local levels of geographic scale.

Finally, the exact economic, social, and political impacts of climate change and the effectiveness of various policy responses remain subject to profound uncertainties. For example, it is difficult to determine the total economic impacts of climate change due to the uneven distribution of benefits and costs of the impacts among affluent and developing countries. In addition, it is challenging to estimate the efficacy of some policy options, such as the geoengineering solution to deliberately spread dust in the stratosphere to reflect sunlight (Schneider, 1989).

Budnitz et al. (1997) and Ascher (2004) defined uncertainty using two categories: 1) epistemic uncertainty: incomplete knowledge about a phenomenon that affects our ability to model it (e.g., inability to determine small effects and impossibility to calculate

outcomes for the multiplicity of interactions among parameters) and 2) aleatory uncertainty: inherent vagueness and infeasible information in a nondeterministic phenomenon (e.g., truly unknowable and unpredictable factors and factors excluded from the model at micro- or macro-levels).

While greater confidence levels have decreased uncertainty with respect to the anthropocentric causes and the probable consequences of climate change, the precise timing and degree of adverse impacts and the potential costs and benefits of policy responses remain undetermined. Skolnikoff (1999) argues that uncertainty in forecasting the details of potential impacts make it difficult to formulate proper public policy because of the inability to identify possible affected interests and measures to reduce emissions.

Nonetheless, Schneider (1989) argues that using scientific uncertainty to justify political inaction is not an objective scientific judgment, but a subjective value judgment. By choosing to wait for more scientific certainty before initiating preventive actions, society takes a (perhaps sizeable) risk of inducing larger magnitudes of climate change. For example, the British economist Sir Nicholas Stern (2007) calculated that delaying mitigation action will increase the costs of future action. Therefore, since it is impossible to diminish scientific uncertainty of global climate change to zero, the problem turns to whether policy makers can make an appropriate judgment to take political action before more tragic circumstances become manifest.

Given that global climate change involves numerous variables, uncertainty seems inevitable in terms of completely understanding the scientifically complex issue. Bray and Von Storch (1999) argue that climate science research is considered to be a good

example of postnormal science for its enormous inherent uncertainties.<sup>10</sup> Therefore, Von Storch (2009) argues that there is a role for social sciences (e.g., economics and culture) to help in constructing some uncertainties that natural sciences cannot address.

### **1.3.3 International Politics Background—International Climate Treaties**

Hempel (2003) contends that after several decades of accumulated scientific evidence, the focus of the global climate change policy debate began to shift to political responses (e.g., establishing an international policy framework with national targets and timetables) during the late 1980s. The record-breaking summer of 1988 and the National Aeronautics and Space Administration (NASA) scientist James Hansen's publicized testimony together triggered media and public attention about the potential of a warming climate (Hempel, 2003).<sup>11</sup>

These factors—increased media and public awareness, continuing scientific warnings, and the establishment of IPCC—successfully placed climate change on the international environmental political agenda (Hempel, 2003). To develop a process of multilateral political cooperation and negotiation, the United Nations (UN) initiated further international efforts in the 1990s—formulating the UNFCCC in 1992 and the Kyoto Protocol five years later.

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<sup>10</sup> This postnormal science concept was defined and characterized by Funtowicz and Ravetz (1985), which refers to an issue or a situation where natural science cannot make concrete statement with high certainty.

<sup>11</sup> Dr. James Hansen, director of NASA's Institute for Space Studies, was invited to testify in front of the Senate Committee on Energy and Natural Resources in 1988. He stated that scientists have detected the signal of climate change and have proved human activities as major forces with a high level of confidence (Hempel, 2003).

United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC, drafted under the auspices of the UN, was signed by 154 countries in 1992 at the Earth Summit in Rio de Janeiro and has been ratified by 189 countries to date. The accord requires participating nations to gather and share information, to launch national strategies for addressing GHG emissions and adapting to expected impacts, and to cooperate in preparing for adaptation to the impacts of climate change (UNFCCC, 2006). The ultimate objective of the Convention is stated in Article 2:

[T]o achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

(UNFCCC, 1992, Article 2)

While this objective showed that the international political community began to acknowledge the threat of climate change, the existence of anthropogenic influences, and the necessity of preventive mitigation actions (instead of mandating national targets and timetables), the Convention remained a non-binding treaty as several industrialized countries had wished. Nonetheless, to reach an international consensus (obtaining support from numerous developing countries), the Convention required Annex I Parties to assume a greater burden in reducing their GHG emissions on a voluntary basis.<sup>12</sup>

The Convention entered into force (subject to subsequent ratification by participating countries) in 1994 and its subsidiary body began organizing a series of meetings known as Conferences of the Parties (COP) to provide a deliberative process to

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<sup>12</sup> Annex I Parties include 41 industrialized countries and entities. Fourteen of them, called Annex I Parties with economies in transition (EIT), are countries that are undergoing the process of transition to a market economy, such as Poland and Ukraine.

develop an international consensus on further national targets and timetables among participating countries. Table 1.1 highlights the major achievement of each of the COPs held over the past 15 years.

**Table 1.1** Major Achievement of Conferences of the Parties (COP) During 1995-2009

COP	Year	Place	Major Achievement
-	1992	Rio de Janeiro	<ul style="list-style-type: none"> <li>✓ Adoption of the UNFCCC in Earth Summit</li> <li>✓ Establish a global consensus on collective actions on stabilizing the global atmospheric GHG concentrations</li> </ul>
1	1995	Berlin	<ul style="list-style-type: none"> <li>✓ Berlin Mandate: strengthen commitments of the Annex I Parties and exempt developing countries</li> </ul>
2	1996	Geneva	<ul style="list-style-type: none"> <li>✓ Initially support the development of a legal instrument</li> </ul>
3	1997	Kyoto	<ul style="list-style-type: none"> <li>✓ Adoption of the Kyoto Protocol—a legally binding treaty</li> <li>✓ Establish country-by-country emissions targets using 1990 emissions levels as baselines</li> <li>✓ Promote three flexibility mechanisms in national responses</li> </ul>
4	1998	Buenos Aires	<ul style="list-style-type: none"> <li>✓ Buenos Aires Plan of Action: commitments to develop monitoring and enforcement mechanisms within two years</li> </ul>
5	1999	Bonn	<ul style="list-style-type: none"> <li>✓ Formulate various operational details for further negotiation</li> </ul>
6	2000	Hague	<ul style="list-style-type: none"> <li>✓ Negotiations on the modalities of the Kyoto Protocol</li> </ul>
	2001	Bonn	<ul style="list-style-type: none"> <li>✓ The Bonn Agreement: political agreement on the modalities of the Kyoto Protocol</li> </ul>
7	2001	Marrakech	<ul style="list-style-type: none"> <li>✓ Marrakech Accords: finalization of the technical details including penalties relating to the Kyoto Protocol</li> </ul>
8	2002	New Delhi	<ul style="list-style-type: none"> <li>✓ New Delhi Declaration: discussion of the clean development mechanism (CDM)</li> </ul>
9	2003	Milan	<ul style="list-style-type: none"> <li>✓ The use of forest sinks projects in the CDM</li> </ul>
10	2004	Buenos Aires	<ul style="list-style-type: none"> <li>✓ 10th anniversary of the entry into force of the UNFCCC</li> <li>✓ Discussion of impacts of climate change and adaptation measures, mitigation policies, and technology</li> </ul>
11	2005	Montreal	<ul style="list-style-type: none"> <li>✓ The first Meeting of the Parties to the Protocol (MOP1)</li> <li>✓ Begin the dialogue about the future action beyond Kyoto Protocol's expiration date in 2012</li> </ul>
12	2006	Nairobi	<ul style="list-style-type: none"> <li>✓ The second Meeting of the Parties to the Protocol (MOP2)</li> </ul>
13	2007	Bali	<ul style="list-style-type: none"> <li>✓ Adoption of the Bali Road Map: agreement on a negotiation plan for the post Kyoto framework (by 2009)</li> </ul>
14	2008	Poznan	<ul style="list-style-type: none"> <li>✓ Agreement on Adaptation Fund for developing countries</li> </ul>
15	2009	Copenhagen	<ul style="list-style-type: none"> <li>✓ Copenhagen Accord—stabilizing the global temperature rise to 2°C above preindustrial levels by 2050</li> <li>✓ Establish an international monitoring and reporting system and the Green Climate Fund to finance developing countries</li> </ul>

Source: Bodansky (2001); Hempel (2003); UNFCCC (2006); UNFCCC (2007)

### Kyoto Protocol

While the international political community acknowledged the ultimate objective of the UNFCCC (i.e., to stabilize the Earth's GHG concentrations), there remains a variety of ambiguities regarding the interpretation of this goal (e.g., what is the safe level of atmospheric GHG concentrations and what is the appropriate time frame?) Reflecting a widespread view, Oppenheimer and Petsonk (2005) assert that a well-recognized safe corridor is 2°C warming and atmospheric GHG concentrations of 550 ppm CO<sub>2</sub>-eq.<sup>13</sup>

It was nonetheless found that the voluntary approach of the Convention was inadequate to achieve the treaty's ultimate objective (Oppenheimer & Petsonk, 2005). Therefore, the famous Berlin Mandate was produced at the first COP in 1995 to commit the Parties to adopt another legal instrument by 1997 that excluded any commitment on the part of the developing nations. The resulting legally binding agreement, the Kyoto Protocol, was finalized in 1997 at the third COP and was ratified by a total of 183 countries as of January 2009. The Protocol was designed to move from the voluntary basis of the Convention to an obligatory commitment to reduce GHG emissions with national targets and timetables.<sup>14</sup>

The agreed target was to reduce GHG emissions in industrialized countries (Annex I Parties) by an average 5.2% below their 1990 levels between 2008 and 2012. Three innovative features based on a premise of multilateral cooperation were included in

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<sup>13</sup> Oppenheimer and Petsonk (2005) compiled several proposed numerical values of "dangerous anthropogenic interference," including: 2°C warming and 450 ppm CO<sub>2</sub> (O'Neill & Oppenheimer, 2002), 2-4°C warming and 550 ppm CO<sub>2</sub> (Oppenheimer & Alley, 2005), and 1°C warming and 450 ppm CO<sub>2</sub> (Hansen, 2005).

<sup>14</sup> Six major greenhouse gases are covered: carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), perfluorinated hydrocarbons (PFCs), hydrofluorocarbons (HFCs), and sulphur hexafluoride (SF<sub>6</sub>).

the Protocol, namely the Clean Development Mechanism (CDM), the notion of Joint Implementation (JI), and the use of Emissions Trading (ET) (UNFCCC, 2007). These designs were meant to encourage Annex I Parties to undertake domestic policies to reduce GHG emissions or to enhance removal by sinks.

These three schemes are called “flexibility mechanisms.”<sup>15</sup> The CDM is a mechanism that allows Annex I Parties to receive credits (Certified Emission Reductions, or CERs) for reducing emissions or increasing carbon sinks if they invest in emission-reduction projects or reforestation projects in developing countries. Similarly, the JI is a mechanism that allows Annex I Parties to receive credits (Emission Reduction Units, or ERUs) for implementing emission-reduction projects or reforestation projects in other Annex I countries. The ET is a mechanism that allows Annex I Parties to acquire emissions allowance (Assigned Amount Units, or AAUs) or other credits (e.g., CERs and ERUs) from other Annex I Parties in an international carbon market (UNFCCC, 2007).

One important and controversial principle in both the UNFCCC and the Kyoto Protocol is the principle of common but differentiated responsibilities.<sup>16</sup> This notion requires developed countries (listed in the Convention as Annex I Parties) to assume most

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<sup>15</sup> These three flexibility mechanisms were first discussed in the third COP in Kyoto in 1997. However, the modalities and technical details (e.g., monitoring and enforcement mechanisms) reached political consensus in the sixth COP in Bonn in 2000 and were finalized in the seventh COP in Marrakech in 2001.

<sup>16</sup> The principle of common but differentiated responsibilities designed to gain support from developing countries seemed reasonable at the time because the Annex I Parties produced two-thirds of global emissions and because historical GHG emissions generated by industrialized countries were primarily responsible for the contemporary problem. However, the rapid increase of GHG emissions from Non-Annex I Parties brought concerns about the effectiveness and fairness of the treaty (Hempel, 2003). For example, one of key reasons for the US withdrawal from the Protocol in 2001 was because President George Bush claimed that the Protocol was a flawed treaty which did not include both developed and developing countries (Bush, 2001).

of the burden for climate protection in terms of reducing their GHG emissions to mandatory targets. However, large developing countries such as China and India (listed in the Convention as Non-Annex I Parties) were only required to maintain non-binding commitments in response to climate change.

In addition to the long drawn-out negotiations concerning detailed mechanisms and instruments within the Protocol (e.g., CDM, JI, and ET), an especially difficult task in this deliberative process was to seek majority support from individual nations to achieve the stipulated criteria for ratification of the agreement before it could go into effect—55 Parties to the Convention, incorporating Annex I Parties which accounted in total for at least 55% of the total CO<sub>2</sub> emissions for 1990 of the Annex I Parties.<sup>17</sup>

The obstacle created by the withdrawal of the US in 2001 hindered the initial implementation of the Kyoto Protocol. However, the agreement finally entered into force in 2005 after it was ratified by Japan, the EU, and Russia.<sup>18</sup> The total percentage of CO<sub>2</sub> emissions from ratified Annex I Parties is 63.7% (UNFCCC, 2009b). The timeframe for

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<sup>17</sup> The Article 25 in the Kyoto Protocol states the stipulated criteria of ratification of this agreement. The standard “the total carbon dioxide emissions for 1990 of the Annex I Parties” means the amount communicated on or before the date of adoption of this Protocol by the Annex I Parties in their first national communications submitted in accordance with Article 12 of the UNFCCC—which lists in detail the required information in national submission.

<sup>18</sup> The Clinton Administration did sign the Protocol in 1997 despite the passage of the Byrd-Hagel resolution, which was passed the Senate by a 95-0 vote in 1997 and which sought to discourage the President from signing any prospective climate protocol that did not include developing countries in the prescribed actions (Byrd-Hagel Resolution, 1997). As a result President Clinton never submitted the Kyoto Protocol to the Senate for ratification. In 2001, President George W. Bush renounced the Kyoto Protocol and withdrew the U.S. from participation. He claimed that the treaty was flawed because of concerns over insufficient grounding in science and technology, potential economic consequences of meeting the even modest reduction target set forth under the Kyoto Protocol, and the fairness of the Protocol which exempted developing countries from mandatory emissions reduction (Bush, 2001; Cohen & Egelston, 2003).

achieving emission targets of the Protocol was a five-year period (2008-2012). During the commitment period, each Annex I Party was required to ensure that its total GHG emissions did not exceed its allowable level of emissions (i.e., the Party's base year GHG emissions multiplied by its emission targets and then further multiplied by five years).

### Post-Kyoto Framework

Through the release of the documentary "*An Inconvenient Truth*" in 2006 and the subsequent joint award of the Nobel Peace Prize to the IPCC and former American Vice-President Al Gore in 2007, the issue of climate change attracted substantially increased public attention and media coverage (Boykoff and Roberts, 2007). The issue also assumed a prominent position at the center of international environmental politics.

Even though it is currently the middle of the commitment period of the Kyoto Protocol (when this dissertation is written) and the results of implementing the Protocol cannot be fully evaluated until 2012, further diplomatic deliberation for a longer-term climate change regime beyond the 2012 expiration year has been proceeding. The Bali Road Map, adopted at the thirteen COP in Bali in 2007, included a negotiating schedule for finalizing a new comprehensive, effective, and sustained post-Kyoto treaty for presentation at the fifteen COP in Copenhagen in December 2009.

However, the original goal—a legally binding treaty to succeed the Kyoto Protocol—was not achieved at the prominently staged Copenhagen climate summit. While the leading advocate, namely the EU, was disappointed about the limited achievement on producing a comprehensive and enforceable action plan (Kanter, 2009), the meeting managed to take a small step forward—receive a commitment from the US and four large developing countries (i.e., China, India, Brazil and South Africa) (Broder,

2009). The final product, the Copenhagen Accord, sets a goal of limiting global temperature rise to 2°C by 2050, provides an international monitoring and reporting system, and establishes a “green climate fund” to transfer funds to developing countries vulnerable to climate change (Revkin & Broder, 2009).

*Political Negotiation—from Rio de Janeiro to Copenhagen*

A number of observations can be made with respect to the international politics of climate change during this fifteen-year diplomatic negotiation (see Table 1.1). First, GHG emission-reduction responsibilities have shifted from a voluntary basis to an obligatory basis due to recognition of the insufficiency of the voluntary approach (Oppenheimer & Petsonk, 2005). Therefore, alternative treaties with specific emission-reduction targets and timeframes (i.e., Kyoto Protocol and a possible post-Kyoto regime) are seeking to effectively stabilize global atmospheric GHG concentrations at a safe level.

In addition, even though the Berlin Mandate exempted developing countries from having to pursue mandatory GHG emission reductions (largely as part of a strategy of enabling a global consensus), Najam et al. (2003) argue that the ultimate objective of the UNFCCC will only be achieved with substantial efforts from developing countries. While launching and implementing the Kyoto Protocol was viewed as the first and necessary step to resolve global climate change by securing initial commitments from industrialized countries, the rapid growth of GHG emissions in developing countries implies that expansion of the scope of mitigation responsibility to developing countries in the post-Kyoto period is inevitable.

Furthermore, it seems clear that some measure of global climate change is unavoidable despite human efforts to stabilize GHG emissions. In addition to continual

efforts to enhance mitigation strategies on the part of countries around the world, the international political dialogue began to emphasize adaptation strategies beginning in 2004. These adaptation measures have included international cooperation in building technological and financial capacity in vulnerable communities.

International political systems are often described as anarchic because there is no structured government above nations to manage world affairs and to enforce transnational agreements. Hence, solutions to international problems must come through cooperation among nations (Thompson, 2006). Thompson (2006) further identifies and analyzes possible political obstacles to international climate cooperation that need to be addressed in three stages (i.e., bargaining, transition, and implementation) (Table 1.2). Two key obstacles are discussed in detail in the negotiation of a cooperative climate regime.

First, Thompson (2006) argues that the consensus of the UNFCCC was easily reached (ratified by 189 countries) because of its basic coordination points, namely global warming is a potential threat to humans, a multilateral approach is needed, the UN is the proper political forum for negotiation and treaty-building, atmospheric GHG concentrations should be reduced, and developed countries should pay a higher proportion of the mitigation cost. However, disagreements due to distributive conflicts (i.e., distribution of costs and benefits) appeared among countries when deciding the baselines and emission-reduction targets of the Kyoto Protocol.

For example, decisions concerning which criteria to use to assign emission allowances (e.g., overall emissions, per capita emissions, emissions compared to gross national product (GNP), and historical emissions) involve conflicts of interests. A consensus was not reached until the final night of the Kyoto conference. In the end, while

developing countries realized their demand with the decision to take historical emissions into account (by only imposing mandatory reduction targets on industrialized countries in the first commitment period), they had to ignore the effect of population (i.e., per capita emissions)—a decision that might hurt them in the future (Thompson, 2006).

**Table 1.2** The Stages and Obstacles of Climate Cooperation

Stage	Cooperation Obstacle	Content
Stage 1 Bargaining	Coordination/standards	Minimum agreement on basic goals and standards
	Distributive conflict	Distribution of costs and benefits across countries for certain designs (e.g., targets)
	Two-level politics	International agreements still requires domestic political support
	Bargaining power vs. efficiency	Countries with strong political power tend to have great bargaining power
	Variable costs of action and inaction	Countries in favor of a strong climate action tend to be more vulnerable to inaction
Stage 2 Transition	Domestic opposition	Insufficient domestic support
	Strategic ratification politics	Delaying ratification may increase bargaining power
	Free riding temptations	Some countries may benefit if there are enough other states participating
	Competitiveness concerns	Countries fear that their economies will be at a competitive disadvantage if they act alone
	Conflicts with trade rules	Potential conflicts between the climate regime and existing trade rules in WTO
Stage 3 Implementation	Incentives to cheat	Lack of enforceable promises out of concern that other countries might not implement
	Monitoring	Sufficient capacity and resources to monitor and verify countries' implementation
	Collective action of enforcement	Little incentive for an individual nation to pay the costs of punishing rule breakers
	Domestic implementation	Various interest groups may circumvent the implementation of international obligations.
	Lack of capacity	Lack of institutional capacity and resources to track the behavior of relevant actors

Source: Thompson (2006)

Therefore, a global consensus may be simply a result of a competition for political power and political compromise. For example, after the US withdrew from the Kyoto Protocol in 2001, the participation of Canada, Japan, and Russia became crucial for the treaty to come into effect. Thus, these countries were able to use their increased bargaining power to pursue their interests at the 2001 Marrakesh meeting. The EU, more enthusiastic participants and leaders throughout the process, had to make a compromise to include new rules in the Protocol—counting carbon sinks for forest and farmland-management practices as reduction credits. This set of rules gave these three countries tens of millions of additional tons of carbon credits (Thompson, 2006).

Although developing countries outnumber industrialized countries, they have less political power. Najam et al. (2003) argue that if developing countries want the post-Kyoto climate regime to incorporate their concerns and interests (e.g., the equality issue of mitigation responsibility on a per capita basis and investment in meaningful capacity development for adaptation in vulnerable developing communities), developing countries need to take more proactive roles in the negotiation process.

The second obstacle affecting international cooperation discussed by Thompson is insufficient domestic support. Take the US as an example. Although President Clinton committed to reducing American GHG emissions by signing the Kyoto Protocol in 1997, he did not submit the Protocol to the Senate for ratification because of the unanimous opposition to the agreement in the Senate (Byrd-Hagel Resolution, 1997). In addition, although President George W. Bush promised in his presidential campaign to establish mandatory reduction targets for industrial emissions, he renounced the Kyoto Protocol after assuming office due to great pressure from business interests (Thompson, 2006).

Given the fact that the US accounts for nearly a quarter of global GHG emissions, Böhringer (2002) argues that the country's withdrawal from the Kyoto Protocol significantly affected the effectiveness of the accord. Therefore, sufficient domestic support appears to not only influence a nation's participation and cooperation in an international climate framework, but lackluster commitment indirectly affects the efficacy of the treaty. Why does a country with strong political power and technological capacity like the US not act proactively to mitigate GHG emissions?

Bazerman (2006) argues that even though American leaders are aware of all of the information necessary to anticipate global climate change and its consequences, both individual cognitive barriers and social structural barriers have impeded the country from taking action—which makes climate change a predictable surprise. Individual cognitive barriers include positive illusions, egocentrism, overly discounting the future, the omission bias, the desire to maintain the status quo, and inattention to data that lack vividness (see Section 2.3.3 and 2.3.5 for a detailed discussion of psychological barriers).

In addition, organizational and political barriers include the specialization of government agencies (i.e., no single agency is responsible for climate change so responsibility is diffused) and corruption of the political system (i.e., the special interest groups like the oil industry lobby elected officials or tilt decisions in their favor with campaign contribution (Bazerman, 2006). Furthermore, Fisher (2006) contends that one reason for American inaction on climate policy is the close relationship between natural resources industries (e.g., oil and coal) and domestic policy making. The abundance of indigenous oil and coal resources and the pivotal role of labor involved in extraction make it difficult for the US to shift its energy structure to cleaner source.

In addition to President Bush's claims of three flaws of the Kyoto Protocol (i.e., exclude developing countries' responsibilities, insufficient science and technology innovation, and inadequate protection against domestic economic harm), Cohen and Egelston (2003) argue that the most significant impediment to the country's participation is the increasingly oppositional relationship between the United States and China. This observation is particularly interesting to follow up in the future because of the tension between these two countries at the Copenhagen climate summit in 2009 (Revkin & Broder, 2009).

In contrast to the decision by the United States to abandon the Kyoto Protocol, the European Union declared its leadership in international climate politics by moving forward with ratification of the accord despite the American withdrawal. On the basis of their comparison of the US and the EU, Vogler and Bretherton (2006) contend that although both sides share a growing understanding of the need to develop alternative energy technologies, the fundamental difference hinges on the divergent ways the two polities interpret scientific uncertainty and gauge the urgency of the problem.

Governments of the major countries in Europe consider global climate change to be real and to require immediate remedial action. Although every nation invariably has its own political and economic considerations, recognition of the critical qualities of climate change appears to be a key factor influencing national engagement (Vogler & Bretherton, 2006). Societal recognition is particularly important in democratic countries because mobilization of public opinion is a key factor driving the direction of government policy making. Therefore, obtaining sufficient domestic support is apparently an essential challenge for a nation to comply with the international climate regimes.

### 1.3.4 Concluding Remarks

As introduced in this section, both science and political domains have made substantial progress in addressing human-induced climate change over the past several decades. Countless scientists have collected scientific evidence to verify anthropogenic forces and attempted to predict the potential impacts of climate change. The current scientific consensus indicates that the observed increase in average global temperature since the mid-20th century is very likely due to increased atmospheric GHG concentrations from human activities (e.g., fossil-fuel use and deforestation) (IPCC, 2007a).

In addition, even if humans were to stabilize atmospheric GHG concentrations and aerosols, the warming trend is unavoidable. In the worse case scenario, the increase in global average temperature is estimated to be 2.4-6.4°C and the sea-level rise is predicted to be 0.26-0.59 meters at the end of the 21st century. The changes in temperature and precipitation patterns will likely affect human society in water resources, ecosystem changes, agricultural productivity, coastal erosion, and public health (IPCC, 2007b).

Due to the state of scientific evidence becoming more certain and increased public awareness, global climate change has been moving up the international political agenda. The UN initiated a series of international efforts such as the establishment of the IPCC and the adoption of international climate treaties. Although it is challenging to achieve a global consensus, the international political community has progressed gradually from an agreement to stabilize atmospheric GHG concentrations (i.e., the UNFCCC), to an agreement requiring the initial implementation of mitigation measures on the part of industrialized countries (i.e., the Kyoto Protocol), and then to a possible agreement

entailing the comprehensive endorsement of mitigation by all nations (i.e., a post-Kyoto regime).

#### **1.4 Dissertation Structure**

This dissertation consists of six chapters in total. The next chapter presents the research rationale by examining several theoretical frameworks for the integration of science and the public in the environmental policy-making process and by reviewing existing sociological findings regarding the public understanding of climate change. The third chapter provides a comprehensive introduction of the case study. The content includes a discussion of the motivation for selecting Taiwan as the focal point of investigation, an analysis of various social values of the Taiwanese people, a review of the development of environmentalism in Taiwan, and an account of various domestic climate policies to date.

The fourth chapter describes the methods used in the empirical portion of this study. The content covers an explanation of the research questions and structure, a discussion about why youth were targeted as the study population, and a series of detailed descriptions of three constituent studies (i.e., an IA focus-group workshop, a comparative survey, and a web-based survey). The fifth chapter reports the results of these studies and analyzes key findings within the context of relevant literature. The final chapter discusses two interesting inquiries in depth and concludes with the policy implications of this study with respect to Taiwan and other Asian countries.

## 1.5 Summary

With decades of efforts in accumulating scientific evidence, the current scientific consensus is that contemporary climate changes in both temperature and precipitation are very likely induced by human activities (e.g., fossil-fuel use and deforestation) (IPCC, 2007a) and that these changes, with temporal and spatial variability, are affecting ecosystems and society in terms of ecosystem changes, agricultural productivity, coastal erosion, and public health (IPCC, 2007b). The international political community has begun to take necessary actions to address the problem by initiating processes to encourage transnational cooperation and negotiation over broad multiparty climate treaties (i.e., UNFCCC and Kyoto Protocol).

While both scientific and political domains have made substantial progress in addressing human-induced climate change over the past several decades, few meaningful results have been achieved in terms of reducing global GHG emissions. To effectively resolve the problem requires interdisciplinary cooperation and collective and sustained effort on the part of many nations. Social scientists can play a role in helping to bridge the different appraisals of laypeople and the scientific and political communities.

In addition, the actual compliance of individual nations to an international mitigation treaty is reliant on obtaining sufficient domestic support (Thompson, 2006). Whether a country—in terms of government and society at large—recognizes climate change as a pressing and prioritized problem that requires urgent action is particularly important in driving the direction of formal policy making in democratic countries. Thus, an interdisciplinary climate-related case study at the domestic level can be useful because countries can learn from one other (Thompson, 2006).

To aid current understanding of the integration of science and the public in the domestic policy-making process, this doctoral research seeks to shed light on whether the public's scientific understanding of climate change is a necessary prerequisite for effective policy making. At a micro-individual level, the study examines Taiwanese youth's general concern about climate change and investigates the interrelationships among three constituent elements (i.e., attitudes, scientific knowledge and behavioral intentions). At a macro-structural level, the study aims to assess the effectiveness of an experimental participatory exercise in enhancing scientific understanding and in formulating climate policies.

The field work of this investigation, conducted in the summer and fall of 2008 in Taiwan, comprises three constituent studies (i.e., an IA focus-group workshop, a comparative survey, and a web-based survey). This case study is expected to contribute in a variety of ways—the findings can be compared with other research; valuable insights about domestic climate policies produced in the experimental participatory exercise can be used by policy makers; and the unique cultural background of this case study can inform future exploratory investigations involving social scientific research on China.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Overview

Because global climate change is a complex scientific-political challenge, mitigation will require scientific research from multiple disciplines and collective efforts from various societal actors. In addition to extensive work on the natural science of climate change and the international politics of the issue, considerable research has been conducted on the problem from various social scientific perspectives. As an empirical study that attempts to explore interrelationships among science, the public, and politics (i.e., whether scientifically literate citizens can facilitate climate policy making), this dissertation focuses on an aspect of critical importance—the public understanding of science.

Studies of the public understanding of science are pursued in several different academic areas including communications (e.g., mass media coverage on science), education (e.g., science education and literacy), and the sociology of science (e.g., science, technology, and society). This research investigates the issue in particular from the perspectives of public policy and the sociology of science. Section 2.2 explains the theoretical research rationale about integrating scientists and citizens in the environmental policy-making process in general.<sup>19</sup> Section 2.3 reviews existing sociological studies regarding public perception and understanding of global climate change. Section 2.4 summarizes the findings of the chapter.

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<sup>19</sup> The chapter interchangeably uses the term “scientists” with “experts” and “citizens” with “the public.”

## **2.2 Science and Citizens in the Formulation of Environmental Policy**

### **2.2.1 Introduction**

Political scientist Frank Fischer (2003a) defines public policy as “a political agreement on a course of action or inaction designed to resolve or mitigate problems on the political agenda and presented in various forms: a law, a rule, a statute, an edict, a regulation, or an order.” In comparison to the range of public policy issues, environmental problems are usually considered to constitute relatively complicated and difficult political dilemmas for policy makers because they involve various disciplines and numerous stakeholders with competing interests. The statement is especially accurate with respect to global climate change—a challenge that affects humans, nonhumans, and ecosystems across space and time. To collectively address the problem, a broad array of societal actors not only need to be involved, but also need to develop their scientific capabilities for making rational and informed decisions.

This section introduces a detailed theoretical framework on the integration of science and public participation in the environmental policy-making process. Subsection 2.2.2 introduces the development of policy studies and then describes the policy-making process for environmental problems. Subsection 2.2.3 explores the role of science in the policy-making process and discusses the central role of “science” in what some authors have termed the “risk society.” Subsection 2.2.4 examines the increasing importance of public participation in the policy-making process in democratic modes of governance. Subsection 2.2.5 explains the rationale and the policy implications of a scientifically literate citizenry in modern society. Subsection 2.2.6 concludes with remarks on the necessity of public understanding of science in the environmental policy-making process.

### 2.2.2 Policy-making Process for Environmental Problems

#### *The Development of Public Policy Study*

Public policy is a political action or inaction formulated and enforced by governments to resolve social problems. The field of public policy studies developed after World War II because of a newly invigorated political interest in confronting issues like poverty, health care, and social welfare (Fischer, 2003a). In addition, due to industrialization and technology advancement, society was forced to address new threats such as nuclear war, novel medical technologies, and environmental degradation (Fischer, 2003b). Historian Stephen Toulmin (1990) argues that it was not possible to address these challenges without considering some underlying social and cultural factors (e.g., the value of human life and humans' responsibility to protect the world of nature).

As a result, Harold Lasswell (1951), considered to be the founder of the policy science movement, envisioned a multidisciplinary approach in his celebrated book *The Policy Orientation*. Lasswell (1951) wanted to create an applied social science that could improve the process and the outcomes of policy decision making and facilitate the development of democratic governance. The resultant product, policy science, was envisioned as a mediator between academics, government decision-makers, and ordinary citizens to provide objective solutions to problems (Fischer, 2003a).

Prior to the multidisciplinary methodological perspective advanced by Lasswell, the field of policy science was dominated by an empiricist methodological framework. This perspective, based on epistemology, argued that the reality of a problem exists as an objective phenomenon and that its causes and effects can be discovered through empirical testing of hypotheses (Fischer, 2003a). Empiricist analysts thus focused (and continue to

focus) on the deployment of technocratic policy-analysis tools such as cost-benefit analysis, risk-benefit analysis, and quantitative calculation of the efficiency and effectiveness of various policies. These empiricist policy analyses, based on assembling what was deemed to be objective scientific knowledge, were not used to any great degree by administrators because they lacked sophisticated understanding of the relationship of knowledge to politics and policy to social scientific expertise (Fischer, 2003a).

Using the energy crisis in the 1970s as an example, deLeon (1988) argued that the empiricist framework could not provide an effective solution for policy makers because the objective technical computing models had little predictive power. Fischer (2003a) argues that the complex energy problem during the 1970s influenced as it was by numerous underlying political and social factors (e.g., foreign policy and the American way of life) had to be reframed in its normative social context rather than simply calculated to discover the technical relationships between supply and demand.

Consequently, instead of making decisions from disinterested quantitative facts, several so-called postempiricist schools of thought have been developed to provide policy makers with alternative methodologies that consider the subjective foundation of social reality (i.e., social, cultural, and political factors) (Fischer, 2003a). By involving a wider range of interests, explanations, arguments, and discourses in the policy-making process, postempiricist analysts seek to provide information of value not only to elite bureaucratic decision makers, but to ordinary citizens as well. This more participatory approach emphasizes deliberative interactions among citizens, analysts, and decision makers (Hajer & Wagenaar, 2003). The ultimate goal is to generate essential information that empowers citizens to have serious public discussions and to make informed choices.

### Constructing Environmental Problems

Most postempiricist policy analyses draw heavily on the notion of social constructionism. As discussed above, the empiricist framework believes that the reality of a problem exists as an objective phenomenon. In contrast, social constructionists believe that the reality of a problem is a creation of the social interaction of individuals, groups, and society (Berger & Luckmann, 1966). What people perceive, understand, and interpret as real (and as a problem) is likely to vary because of their different worldviews as influenced by culture, education, economic status, and so forth. In other words, the reality of a problem is not an objective, fixed answer, but is formed by the varying ways in which the social realities of the world are shaped and perceived by members of society (Gergen, 1999).

The identification of a problem is critical because it is through such framing that political systems decide whether there is a need to initiate a new policy or to change an existing one. It is for this reason that social constructionists are particularly interested in discovering how an issue comes to be recognized by the government (and the society at large) as sufficiently important to be put on the political agenda for consideration. This so-called “agenda-setting” stage is influenced by various scientific, social, and political factors: the mobilization of adequate evidence pertaining to the existence of a problem, the societal recognition of the situation as a problem, the exercise of organized group pressure, the available resources to deal with them, and the political climate or willingness to act (Kraft & Vig, 2003; Kingdon, 1995).

Similarly, sociologist John Hannigan (1995) argues that the successful social construction of an environmental problem rests on six essential factors: 1) scientific authority for and validation of the claims; 2) existence of “popularizers” who can bridge

environmentalism and science; 3) media attention in which the problem is framed as novel and important; 4) dramatization of the problem in symbolic and visual terms; 5) economic incentives for taking positive action; and 6) emergence of an institutional sponsor who can ensure both legitimacy and continuity.

First, it is a prerequisite to obtain scientific validation of the problem from a variety of sources of scientific expertise. Second, Hannigan (1995) contends that it is essential to have “scientific popularisers” who can bridge elite scientists and other environmental activists (e.g., journalists and political leaders) by transforming and reframing esoteric scientific findings into proactive environmental claims. Third, media coverage of the environmental problem is a crucial factor because the problem will be placed on the public and political agenda only if the public considers the problem to be important. Fourth, Hannigan (1995) argues that environmental problems need to be dramatized in highly symbolic and visual terms that are easily communicated to the public. For example, stratospheric ozone depletion only began to attract the public’s attention after the graphic metaphor of “an ozone hole over the Antarctic” was invoked. He argues that such images “provide a kind of cognitive short cut compressing a complex argument into one which is easily comprehensible and ethically stimulating.” Fifth, to prevent or reduce potential opposition, it is necessary to highlight the economic benefits of a particular course of policy action or to provide economic incentives for taking positive actions to address environmental problems. Finally, obtaining institutional support is significant especially once the problem moves up on the political agenda and the follow-up policy-making process begins to gather momentum (Hannigan, 1995).

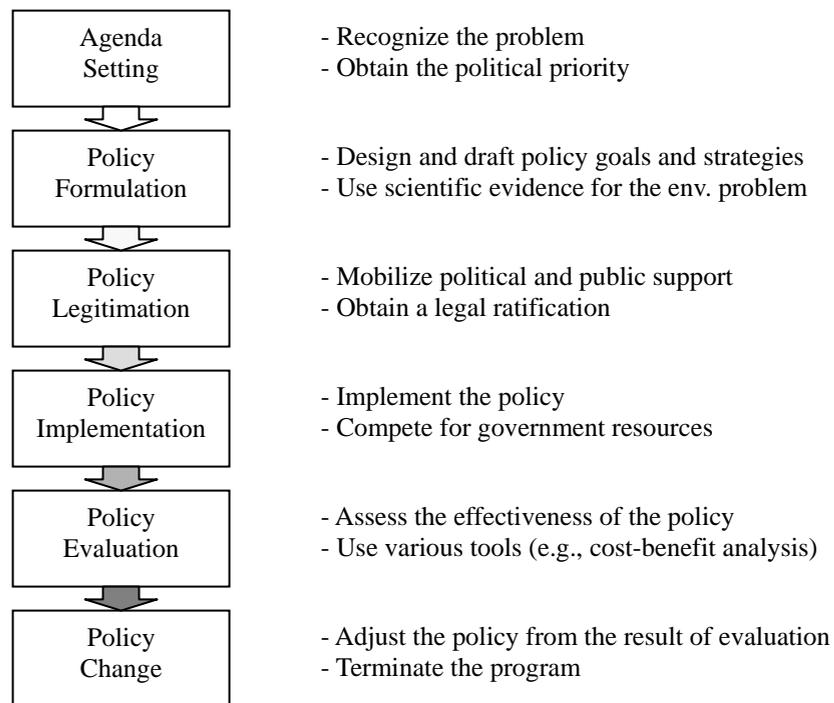
In other words, to be successfully constructed as a valid problem the issue not only needs to be verified by scientists, but needs to be regarded as such by a concerned public, covered by the media, advocated by interest groups, and recognized and supported by politicians. However, Downs (1972) famously argued that public interest about a problem will experience a cycle: public interest is negligible in the pre-problem stage; is awakened by a dramatic event or discovery; is intensified during the problem-solving process; and then gradually declines. While most environmental policy-making processes are lengthy and media coverage on dramatic events does not persist indefinitely, it is a challenge for policy makers, scientists, and environmental activists to retain the public's interest over the full span of the required stages.

### *The Process of Policy Formulation*

Although different authors employ various terminologies to describe the policy-making process, most policy issues follow a common sequence of five stages: policy formulation, policy legitimation, policy implementation, policy evaluation, and policy change (Figure 2.1) (Kraft & Vig, 2003; Anderson, 2000). After a problem assumes a position on the political agenda, various actors (e.g., president, governmental agencies, and legislators) can directly design and draft an appropriate policy and program (e.g., goals and implementation strategies). The stage of policy formulation usually requires the participation of experts who supply scientific evidence and the formulation of socioeconomic impact assessments of the environmental problem for policy makers.

The drafted policy then enters the process of legitimation which means the policy needs to be ratified formally by legislators or authorized by governmental agencies depending upon the level of the policy (e.g., a statute, a rule, or an order). In addition, this

process is a highly politicized stage because it often requires obtaining political and public support (i.e., support from different political parties and stakeholders) (Switzer, 2004). The next stage is to put the legitimized policy and program into effect through administrative decisions. Switzer (2004) argues that this stage may involve conflicts among bureaucracies because competing agencies (or even different divisions in the same agency) may be forced to vie against one another for institutional resources.



**Figure 2.1** The policy-making process in the policy-cycle model with different stages.

The stage of policy evaluation refers to a process to measure the effectiveness of the policy and to assess whether the policy has achieved its objectives. The appraisal can take a variety of forms such as cost-benefit analysis, feedback from interest groups, or simply personal judgment by policy makers (Switzer, 2004). The outcome of the

evaluation is then used to modify the goals, means, and strategies of the policy or to terminate the program in the final stage of policy change. This so-called policy-cycle model not only emphasizes all phases of policy making, but also highlights its continuousness and changing condition—a policy may be reevaluated and revised because of new information or shifting opinions (Kraft & Vig, 2003; Anderson, 2000).

### *Characteristics of Environmental Problems*

The process of public policy making invariably involves a variety of actors (e.g., politicians, scientists, interest groups, and the public) and the success of the process is influenced by numerous scientific, social, and political factors. Among diverse problems on the political agenda, environmental problems are usually viewed as especially difficult for policy makers to manage because of seven core characteristics: their public nature, transboundary features, complexity and uncertainty, irreversibility, temporal and spatial variability, administrative fragmentation, and regulatory intervention (Carter, 2001). These characteristics—involving scientific, social, and political factors—often influence different stages of the policy-making process. Global climate change contains all seven features and is used as an example in the following discussion.

First, many environmental resources are public goods which means that their benefits are shared without discrimination (Weale, 1992). However, while the benefits from using a public good are often limited to a small group of people, the costs are spread widely. This feature can be best explained by the renowned idea of the “tragedy of the commons” proposed by the late ecologist Garrett Hardin (1968). He argued that the pursuit of individual interest in common resources will usually result in harm if in the absence of any social or political controls because people tend to maximize their own

benefit and overuse or overpollute common resources. While Hardin proposed a mutual cooperative approach (e.g., a society-recognized regulation), it is often difficult for policy makers to determine who should gain the benefit and to achieve a consensus that is acceptable to the community as a whole.

Second, the tendency of environmental problems to transcend political boundaries is an especially salient feature of global common resources. Many such problems are not limited to a nation's borders and jurisdictions (e.g., air pollution and cross-boundary river pollution).

Third, the interconnectedness of the ecosystem increases the complexity and uncertainty of environmental problems because it is difficult to completely identify the interdependent relationships between natural and human-made phenomena. While science and professional expertise can provide objective scientific knowledge of the nature of the problem, the unknown facts and contrasting views among scientists frequently slow down the pace of the policy-making process and contribute to the displacement of the problem (Carter, 2001).

Fourth, some environmental problems are irreversible because many natural resources are finite. If these resources are exhausted or a vulnerable species becomes extinct, there is no way, even with the most advanced technology, that humans can recreate these resources or bring those species alive. As a result, policy makers bear a great responsibility to prevent those destructive environmental problems.

Fifth, some long-term and wide-spread environmental impacts tend to affect particular subpopulations of people in time and space. Uneven temporal and spatial distribution of the costs and benefits of environmental problems creates difficult ethical

issues for policy makers (i.e., intragenerational justice and intergenerational justice) (Carter, 2001).

Finally, the last two characteristics—administrative fragmentation and regulatory intervention—are related to the structure and policy-making capabilities of modern governance. Although the government comprises numerous agencies with specific responsibilities, it is common to find that a specific agency neglects others due to a lack of horizontal coordination. This dilemma is particularly problematic with respect to environmental matters because many of them are often the byproducts of other policy domains (e.g., soil erosion due to intensive agricultural practices) and many environmental policies conflict with other policy areas (Carter, 2001). Therefore, policy makers in an environmental agency specifically need to seek out the cooperation and coordination across customary institutional boundaries.

Take global climate change as an example. Since the atmosphere is considered to be a common resource, every industry and every nation emits GHGs that collectively contribute to the increased GHG concentrations in the atmosphere. It has been exceedingly difficult for policy makers to initiate a satisfactory program regarding who should be allowed to emit CO<sub>2</sub> and how much should be permitted. In addition, the potential consequences of global climate change are often long-term, transboundary, and irreversible. The benefits and costs of emitting GHG are unevenly distributed in time and in space. It is a challenge for policy makers to pinpoint the responsible parties and potentially affected groups.

Moreover, the complexity of the ecosystem increases the difficulty for scientists to construct the empirical relationship between anthropogenic forces and the phenomena

and to assess and predict the exact potential impacts. This scientific uncertainty influences the general public's perceptions about the existence of the problem, and in turn, its support of any resultant policies. Furthermore, since global climate change is a by-product of industrial development, climate policies need the involvement of a broad array of administrative institutions responsible for transportation, energy, forestry, and economic policy.

### Summarized Review

In brief, with the increasing complexity of modern techno-industrial societies, the information requirements for policy makers have been intensified. Traditional empiricist policy analyses based on objective scientific knowledge are not sufficient for administrators to enable policy makers to engage with contemporary environmental problems. There is thus a need for a multidisciplinary postempiricist framework that emphasizes deliberative interactions involving a wider range of interests in the policy-making process. While numerous scientific, social, and political factors may influence the policy-making process for environmental problems, two groups of actors and their contributions (i.e., scientists and the public) are key to the deliberative process. The next two subsections specifically discuss the roles of these two sets of actors.

### **2.2.3 Science and the Policy-making Process**

#### Transformation of Scientific Practices

Subsection 2.2.2 highlights the importance of science in the contemporary environmental policy-making process. During the past few decades, some scholars have argued that there has been a transformation in scientific practices from disinterested and

non-utilitarian “Mode 1 science” to cross-disciplinary “Mode 2 science” (Gibbons et al., 1994). The concept of Mode 1 science was formalized in a well-known essay written by sociologist Robert Merton (1942). To rescue science from powerful political interference by autocratic regimes during and after World War II, Merton (1973) argued that it was necessary to maintain the autonomy of modern science that renders scientific knowledge independent of social influences from other institutional spheres (e.g., religion and economics). The transparent process of scientific inquiry—through peer criticism—means that it needed no future external supervision. Science should be left alone to produce disinterested and universal truths.

While Merton’s argument was intended to prevent science from being politicized and to ensure its integrity, it seems impossible to keep science entirely “independent and disinterested” from other institutional interests because it has come to be embedded with so many pivotal developments of modern society (e.g., national economies and the military advantages of states) (Jasanoff, 2006). In addition, the modernization of science and technology has generated pervasive and inescapable risks that threaten the health and safety of people and the environment (Beck, 1992). Sociologist Ulrich Beck (1992) famously argues “today risk is once again increasing as technology, largely owing to reflexive modernity, becomes inherently complex. Accidents and crises largely become unpredictable, and governments lose control of the regulatory structures which contain such accidents and crises.”

Due to the increasing complexity and uncertainty of modern techno-industrial societies, both decision makers and the public require that science provides not merely true and reliable knowledge, but some in-depth insights regarding the implications of the

knowledge (e.g., purposes and effectiveness). As a result, scientific practices have expanded to Mode-2 science which is mission-oriented on a cross-disciplinary basis and embraces growing public demands for accountability (Nowothy et al., 2001). Mode-2 science has been developing with the emergence of public science to include “policy-relevant knowledge in the broadest sense: science that underwrites specific regulatory decisions, science offered as legal evidence, science that clarifies the causes and impacts of phenomena that are salient to society, and science that self-consciously advances broad social goals, such as environmental sustainability” (Jasanoff, 2006).

#### *Roles and Functions of Science in the Policy-making Process*

As a result of the transformation of scientific practices, science now assumes an increasingly significant role in the political arena. Susskind (1994) argues that scientific advisers can play five primary roles in the environmental policy-making process: trend spotters, theory builders, theory testers, science communicators, and applied policy analysts. First, trend spotters usually are scientists who first observe changes in the patterns in ecosystems or recognize perturbation in longitudinal data and then determine the significance of the problem.

Second, theory builders verify the observations initially reported by trend spotters, explore the causes of the problem, and build models to explain past circumstances and to predict future effects (Hannigan, 1995).

Third, theory testers play a significant role in increasing the credibility of the scientific claims by testing the hypothesis and the resultant models assembled by the theory builders. These three roles are usually more prominent during the fact-finding stages (i.e., problem recognition and agenda setting) (Hannigan, 1995).

Fourth, scientists can play a role as science communicators that translate the technical language into plain language that is easier for the public to understand. This task means that the scientific understanding of environmental problems is not only limited to a small group of elite scientists, but is relevant to a wider group of lay people (Hannigan, 1995; Reddy, 2009). Lasswell (1941) and numerous others have argued that one of the professional's responsibilities is to educate citizens and to build their scientific capability to intelligently participate in deliberations on public affairs.

Finally, scientists also act as policy analysts that provide policy recommendations to policy makers. The most common institutional form for delivering this information is the scientific advisory committee comprising various experts. Both roles (i.e., science communicators and policy analysts) are more dominant during the negotiation/bargaining period (i.e., policy legitimation and implementation) (Susskind, 1994).

Similarly, Ascher (2004) discusses five political functions that scientific expertise can serve for decision makers. Scientists can assist policy makers by identifying the problem, outlining potential policy options, conveying the scope of scientific uncertainty, projecting the likely outcomes of the policy options, and evaluating the effectiveness of the resultant policy. Nevertheless, despite these political services, Ascher (2004) contends that scientists still need to overcome some inherent conditions for conflict with policy makers. Government agencies often suppress, oversimplify, and distort scientific information for their own institutional interests (e.g., to enhance their authority and budget). For example, scientific uncertainty and disagreement among scientists regarding global climate change is often manipulated to justify the delay of action or to perpetuate inaction (Brunner, 2001).

*Approaches of Science in the Policy-making Process*

It is instructive to explore exactly how science fulfills these various functions during actual policy-making processes. Irwin (1995) describes three approaches through which science can assist decision makers to respond to environmental threats: the expert approach, the democratic approach, and the pragmatic approach. First, the expert approach, mostly observed in the form of formal “scientific advisory committees,” has long been utilized by policy makers. The committee consisting of numerous scientific specialists seeks to provide independent, neutral, and objective scientific expertise. However, this approach has been shown to have numerous flaws that arise from its inability to achieve policy resolution because an overemphasis on expert assessment may differ sharply from the knowledge of other stakeholders, lower possibilities for a wider policy debate and appraisal, and generate legitimation problems (i.e., doubt over the justification of an action simply by the conclusion of the committee) (Irwin, 1995).

Second, the democratic approach mostly occurs in the form of public inquiries or hearings, and involves a broader representation of expert views (e.g., interested members of the public) in the process compared to closed advisory committees. Even though this participatory mode provides opportunities for wider cross-examination and exchange of technical expertise, it also has attracted criticism. For example, lengthy deliberations tend to become inefficient, costly, and even ritualized—citizens are more like passive audiences rather than active participants. In addition, while involving more participants with various interests, the process sometimes just exacerbates conflict (Irwin, 1995).

Finally, the pragmatic approach is less formalized and more flexible compared to the previous two decision modes. Unlike the other models that are based on claims to

“independence and expertise” and “representation and democracy,” the pragmatic approach focuses on “practicability and manageability” (Irwin, 1995). One means of implementation entails a committee or task force that comprises not only scientific experts, but also representatives of stakeholder and other social groups (e.g., labor organizations). In spite of the difficulties that lay representatives may encounter in fully understanding the finer points of technical discussion, this attribute can be a key strength. To ensure that the resultant policy is manageable, workable, and enforceable, such committees often stay away from radical and difficult political strategies (Irwin, 1995).

#### *Challenges of Sufficient Scientific Evidence*

Although science plays multiple functions in the policy-making process, there are some problems that remain to be addressed. Environmental social scientist Andrew Blowers (1993) argues that obtaining sufficient scientific evidence and sound scientific judgment of environmental problems is challenging for policy making in five ways. First, it is difficult to establish causal relationships especially in cases that require assignment of responsibility for externalities produced by certain polluters. Second, it is difficult to forecast exact impacts (e.g., incidence, distribution, time, and effect) because the estimation of probabilities will vary under different assumptions. Third, uncertainty will always exist when evaluating potential risks imposed on future generations. Fourth, the absence of environmental data often leads to manipulation by vested interests against environmentalists. Finally, complex environmental scientific problems often involve broad speculative ideas and fragile interpretations which often have difficulty surviving in the political arena of competing interests (Hannigan, 1995).

### Summarized Review

In brief, the traditional (and highly untenable) approach calls for the presentation of findings by scientific experts who then hand over responsibility to policy makers. However, information requirements on the part of policy makers and the general public have been intensified because of the proliferation of environmental threats in modern techno-industrial society. Therefore, there is an increasingly significant role for science to take on more expansive roles in the policy-making process as policy analysts and science communicators. For scientists to transform complex environmental problems to the non-scientific world, citizens are presumed to need to demonstrate capability to participate effectively in deliberations on public affairs.

#### **2.2.4 Citizens and the Policy-making Process**

As discussed in Section 2.2.2, there is an increased need to include a wider range of perspectives in the policy-making process involving scientifically complex environmental problems. The public is not only a key actor in constructing environmental problems (i.e., providing lay perspectives in the deliberative process), but also an important driving force in formulating and implementing policies to address controversial environmental issues. This situation implies that a policy or problem that lacks public support will unavoidably encounter political and societal opposition in systems of democratic governance.

### Administrative Rationalism vs. Democratic Pragmatism

Political scientist John Dryzek (1997) discusses three coordination mechanisms through which human beings can solve environmental problems: administrative rationalism,

democratic pragmatism, and economic rationalism. Economic rationalism seeks to rely on market mechanisms to mitigate environmental problems through a variety of strategies such as taxes, fees, incentives, and cap-and-trade schemes. Although it has been the most prominent approach over the past two decades, Dryzek (1997) argues that the other two mechanisms have achieved more substantial success in the real world. Therefore, the discussion here will focus on how these two mechanisms—expert-driven administrative approaches and citizen-driven democratic approaches have been employed in practice.

Administrative rationalism is defined as “the problem-solving discourse which emphasizes the role of the expert rather than the citizen or producer/consumer in social problem solving, and which stresses social relationships of hierarchy rather than equality or competition” (Dryzek, 1997). This policy discourse is a traditional problem-solving approach with a strong alliance between scientific experts and professional administrators. Administrative institutions in resource management and pollution control have often sought to solve problems by employing practices that rely on the contributions of privileged scientists at some level (such as providing scientific evidence of the problem in the environmental impact assessment process) and policy recommendations with rationalistic policy analysis techniques (e.g., cost-and-benefit analysis) (Dryzek, 1997).

Dryzek (1997) argues that traditional expert-driven administrative rationalism is not an effective problem-solving discourse in the context of complex problems because of the following reasons. First, hierarchy is based on expertise, but the complexity of the problem makes it nearly impossible for an expert to synthesize sufficient knowledge from different perspectives.

Second, the Weberian compartmentalization of bureaucratic structure tends to produce problem displacement rather than problem solution. Since most governments have specialized agencies and divisions, it is common to observe the displacement of problems—for example, apparent efforts to “solve” air pollution create water pollution problems. It is quite difficult to integrate different agencies and to manage solutions that transcend the divisions (Dryzek, 1997).

Finally, implementation deficits are common under administrative rationalism: gaps between the expected outcomes of high-level executive decisions and the actual achievements at street level (Weale, 1992). The well-known inadequacies associated with strict command-and-control regulatory policies demonstrate that effective compliance with policy decisions requires simultaneous compliance, negotiation, and coordination of agency officials, polluters, developers, and resource users (Dryzek, 1997).

As a partial resolution to some of these problems, Dryzek (1997) argues that democratic pragmatism affords a useful corrective. The democratic concept of this mechanism does not mean to hand over the responsibility of problem solving from environmental administrations to the public or to the representatives of various interest groups, but it seeks to make administrations more responsive by involving a plurality of perspectives. The democratization of administrations is essential because of the need to secure legitimacy for decisions in interactive policy-deliberation processes.

The biggest challenge that democratic pragmatism needs to confront is the uneven political power distribution and the unequal financial resources of different interest groups (Dryzek, 1997). While the pluralist concept of democratic pragmatism views all actors and interests as equally legitimate, it is expected that powerful interests with large

financial resources (e.g., major corporations and industry groups) will have greater political influence on policy debates in capitalist democracies. Not only can business allocate more financial resources both in advertising its corporate image and in lobbying politicians and legislators, but also the privileged position of business in affecting national economic standing (e.g., through gross domestic product and employment) means that it will likely be more politically influential than other interest groups.

Nonetheless, a democratic approach is likely more effective in resolving complex environmental issues. Fischer (2003a) argues that broad public participation brings a number of benefits to democratic policy development and implementation, namely providing unique lay perspectives, decreasing conflict over a dispute, expanding acceptance and support of decisions, increasing legitimacy, and improving the public's knowledge about policy problems.

In addition, the importance of public participation in achieving sustainable development has been recognized in several international documents (e.g., Agenda 21, Rio Declaration, and Johannesburg Declaration) and treaties (e.g., UNFCCC) (Segger et al., 2003). However, the principle of public participation in these diplomatic declarations primarily focuses on ensuring basic human rights in three aspects: rights of expression, access to information, and access to justice.<sup>20</sup>

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<sup>20</sup> The principle is based on the Aarhus Convention (Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters), that was drafted in Denmark in 1998. The objective of this document is to protect the rights of every person of present and future generations to live in an environment adequate to his/her health and well-being in terms of access to information, public participation in decision-making, and access to justice in environmental matters.

Segger et al. (2003) argue that effectively implementing public participation in sustainable development policies requires a sustained and concerted effort on the part of civil society that includes opportunities for outreach to civil society events (e.g., stakeholder dialogues and experts' roundtable). The growing scope of civil society activities that involve the general public in environmental matters implies that the role of the public in the policy-making process has shifted from one of passive information recipient to one of active opinion contributor.

### Public Participation Methods

Numerous different methods (e.g., public hearings and consensus conferences) have been developed to involve the public in decision making regarding complex issues of science, technology, and environment over the past few decades (e.g., biotechnology, waste repository, radioactive sites, and food risk) (see Rowe & Frewer, 2000). Many researchers have defined and distinguished these participatory methods in different categories such as the formality of the process, the nature of participants, the extent of involvement, and the objectives of participation (e.g., Dryzek, 1997; Rowe & Frewer, 2000; Beierle & Cayford, 2002).

Dryzek (1997) defined the public participatory practices in the environmental policy-making process with five categories: public consultation, alternative dispute resolution, policy dialogue, public inquiries, and right-to-know legislation. Beierle and Cayford (2002) examined five mechanisms: public meetings and hearings, advisory committees not seeking consensus, advisory committees seeking consensus, and negotiations and mediations. Rowe and Frewer (2000) reviewed and evaluated eight public participatory methods: referenda, public hearings/inquiries, public opinion surveys,

negotiated rule making, consensus conference, citizens' jury/panel, citizen/public advisory committee, and focus groups (Table 2.1).

**Table 2.1** Public Participation Methods

Methods	Participants	Duration	Key Mechanism
Referenda	All member	Single event	All participants directly vote on a decision with equal influence. Final outcome is binding.
Public hearings/inquiries	Interested citizens	Weeks to years	Participants may voice opinions in an open forum but have no direct impact on recommendation.
Public opinion surveys	Large sample (representatives of public)	Single event	Participants may voice opinions in a standardized survey via face-to-face, telephone, or internet.
Negotiated rule making	Small sample (stakeholder groups)	Days to months	Participants work as a committee to reach a consensus on a specific question or regulation.
Consensus conference	Small sample (representatives of public) (10-16 people)	Weeks of preparation and 3-4 days of conference	Participants discuss key issues with assistance of independent facilitators and expert presentations. Conclusions on key questions are presented via citizen reports or press conference. The process is open to the public.
Citizens' jury/panel	Small sample (representatives of public) (12-20 people)	4-10 days	Participants discuss key issues with assistance of independent facilitators and expert presentations. Conclusions on key questions are presented via citizen reports or press conference. The process is not open to the public.
Citizen/public advisory committee	Small group of stakeholders	Days to months	Participants discuss key issues with interaction with industry representatives.
Focus groups	Small group (representatives of public) (5-12 people)	Single event	Participants discuss general issues. The process is video/audio recording to assess opinions/attitudes.

Source: Rowe and Frewer (2000)

The discussion here reviews some common practices based on the extent to which decision makers intend the public to be involved. The extent of public involvement can be reviewed from the lowest level (e.g., the public receives relevant information), to the medium level (e.g., the public casts a vote in a referenda and the public provides their

opinions in a survey or a hearing), and to the highest level (e.g., the public participates in exercises with some degree of decision-making authority) (Rowe & Frewer, 2000).

First, the least the public can be involved in decision making is to receive relevant information with the purpose of protecting the public's right. With the passage of a series of right-to-know legislation (i.e., the federal Administrative Procedure Act in 1946, the Freedom of Information Act in 1974, and the federal Emergency Planning and Community Right-to-Know Act in 1986), the US government recognized citizens' rights to participate in agency rulemaking and to have access to relevant scientific and technical information (Dryzek, 1997).<sup>21</sup>

These laws have aimed at increasing the transparency of governmental decision making, including an appropriate breadth of perspectives, legitimizing governmental actions, and tailoring specific policy frameworks. However, both the purpose and the degree of openness and transparency in science are context-specific and are sometimes traded off against other important social values such as the privacy of research subjects and the confidentiality of proprietary business information (Jasanoff, 2006).

Second, the public can be involved in decision making at a medium degree by voicing opinions via different mechanisms (e.g., voting in a referenda and participating in surveys, focus groups, and public hearings). For example, public hearings are mandatory procedures in the United States required by the National Environmental Policy Act and this process requires that policy makers document both the public's comments and the

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<sup>21</sup> The Emergency Planning and Community Right-to-Know Act was part of hazardous waste regulations in the United States (i.e., Comprehensive Environmental Response, Compensation, and Liability Act). It provides the public access to information about hazardous chemicals present in the community by requiring operators of facilities reporting information regarding the presence of hazardous chemicals.

responses to these comments for large-scale, publicly-funded development proposals as part of the process of preparing environmental impact statements (EISs) (Dryzek, 1997).

These mechanisms, considered to be one-way communication, have little or no interaction (e.g., dialogues and debates) among various stakeholders. While the public receives information from expert testimony in public hearings, their comments have little influence on the decisions presented in the hearings. In contrast, while members of the public are allowed to voice their opinions in referenda, surveys, and focus groups, they have restricted access to information and resources to enable them to make informed decisions (Rowe & Frewer, 2000).

Finally, in contrast to the basic assurance of the public's right to have access to relevant information or the medium involvement of collecting public opinions, a variety of participatory methods are aimed at engaging the public in more meaningful discussions involving well-designed deliberation processes. Deliberation is a necessary communication process for a democratic approach that involves a variety of actors in policy-making processes (Dryzek, 1997). According to Reich (1990), deliberation refers to "a process of social learning about public problems and possibilities" and the goal of deliberation is "the creation of a setting in which people can learn from one another."

As a result, methods such as consensus conferences and citizens' juries/panels provide the participants with resources and information to make informed decisions. A small group of participants is selected as representatives of certain populations to deliberate key issues. During the process independent facilitators are present to assist the discussion and experts are invited to provide relevant information. Conclusions of the conference on key questions are presented via citizen reports or press conferences.

However, the influence on the final decision is not guaranteed like in a referendum (see a detailed discussion of consensus conferences in Subsection 2.2.5).

Each of these participation methods has its strengths and weaknesses. Rowe and Frewer (2000) argue that a variety of contextual and environmental factors (e.g., national political styles, the role of government, and sensitivity of the focus issue) may influence the effectiveness of the method. As a result, there is no perfect method for a certain situation. Nonetheless, while one key benefit of broader public participation is to increase the legitimacy of the decision, it is particularly important to gain representative public samples in some small sample group-based mechanisms.

### *Summarized Review*

In short, Dryzek (1997) argues that the citizen-driven democratic approach is a more effective mechanism than the expert-driven administrative approach for solving complex environmental problems of modern democratic governance. Public participation is not only a procedure that legitimates policy decisions, but it is a process that can enhance the quality and the effectiveness of policy decisions (e.g., greater public satisfaction with adopted policies). Numerous participatory experiments involving deliberative discussions with the involvement of a variety of perspectives have been conducted in connection with a wide range of environmental issues (e.g., biotechnology, waste repository, radioactive sites, and food risk) (see Rowe & Frewer, 2000).

However, in this deliberative and social learning process, one key information source for the participatory public is scientific experts. As noted in Subsection 2.2.3, scientists ideally need to act as communicators and educators that attempt to build the public's intellectual capability to meaningfully engage in complex environmental

policy-making processes. Interestingly, while the public tries to understand the scientific context of complex environmental problems, it is incumbent on scientists and policy makers to simultaneously attempt to understand unique lay perspectives. A cooperative and mutually beneficial relationship between scientists and the public prompts the development of the public understanding of science research—an important subject that will be discussed in the following subsection.

### **2.2.5 Public Understanding of Science**

#### *The Public's Need to Understand Science*

As discussed in the previous subsection, while public participation is an important policy-making process of democratic governance, the outcome of deliberation will be most rational and meaningful when the involved citizens are intellectually capable of making informed decisions. This need has prompted establishment of a field of scientific research organized around the public understanding of science and the key focus of scholars and other practitioners working in this domain is to measure and explain the content and the degree of the public's scientific understanding and to find remedies for the public's apparent ignorance or misunderstanding of science (e.g., Wynne, 1995; Irwin & Wynne, 1996; Gregory & Miller, 1998).

Many authors have discussed the public's need to understand science and its benefits. Haldane (1939) argued many years ago that the ordinary person must know something about various branches of science because these matters affect his everyday life. In the years following World War II, the Association of Scientific Workers (1947) advanced three common justifications for an improved public understanding of science: a technically literate population is essential for future workforce requirements, science

becomes an important part of cultural understanding, and greater public understanding of science is deemed to be indispensable for a modern democracy.

The Royal Society of London (1985) emphasized in a widely circulated report entitled *The Public Understanding of Science* that better technical comprehension would enrich society and improve the quality of decision making in terms of national prosperity, economic performance, public policy, personal decisions, everyday life, risk and uncertainty, and contemporary thought and culture (see Irwin & Wynne, 1996).

Durant et al. (1989) assert that the public needs to care about science for four reasons: 1) cultural literacy: people should know about science—the greatest achievement of human culture; 2) practical functionality: people need to know about science because science-based technologies affect everyone’s life; 3) democratic resilience: only informed public debate can assist the democratization of science-related policy decisions; 4) attitudinal familiarity: the public support for science is based on a minimal level of public knowledge.

#### *Public Understanding of Science Research*

Public understanding of science research involves several disciplinary and interdisciplinary fields. While numerous surveys on public attitudes about science have been conducted since the 1950s, it was not until the 1980s that systematic inquiries began to develop (Wynne, 1995). Bauer et al. (2007) reviewed the development of “public understanding of science” studies and compiled the research agenda into three paradigms in three time periods—Science Literacy, Public Understanding of Science, and Science and Society (Table 2.2).

**Table 2.2** The Development of Public Understanding of Science Research

Paradigm/Period	Attribution Problems	Proposal Research
Science Literacy 1960s-mid 1980s	Public deficit Knowledge	Literacy measures Education
Public Understanding of Science After 1985	Public deficit Attitudes Education	Knowledge-attitude Attitude change Image marketing
Science and Society 1990s-present	Trust deficit Expert deficit Notions of public Crisis of confidence	Participation Deliberation “Angels” mediators Impact evaluation

Source: Bauer et al. (2007)

Beginning in the 1960s, the scientific literacy paradigm explored questions pertaining to whether members of the public were scientifically literate in terms of basic understanding (i.e., abilities in reading, writing and numeracy) and political literacy (i.e., the knowledge of the political process) (Bauer et al., 2007). John Durant (1993) further defined scientific literacy in accordance with three aspects: knowing a lot of science (content), knowing how science works (process), and knowing how science really works (implication). He argues that knowledge of scientific facts and knowledge of the scientific method do not imply an understanding of their significance, so what the public needs to know is how scientific knowledge is generated: how scientific investigations are conducted and how scientific decisions are made (Gregory & Miller, 1998).

The National Science Foundation (NSF) in the US carried out a series of surveys of public attitudes and knowledge about science and technology during the 1970s as part of its “science indicators” program. Jon Miller (1998), the designer of the NSF surveys, claimed that a scientifically literate citizen needs to have 1) a basic vocabulary of scientific terms and constructs; and 2) a general understanding of the nature of scientific

inquiry. Miller (1998) expects a scientifically literate citizen to be able to read and comprehend the Tuesday science section of *The New York Times*. Similarly, Durant et al. (1989) designed the Oxford Scientific Knowledge Scale with two dimensions: the content (i.e., elementary scientific knowledge) and the process (i.e., scientific research method).

Durant et al. (1989) also conducted surveys of scientific literacy in 1988 in the US and the UK. These surveys contained a series of quiz-type questions that examined the public's overall level of scientific understanding in various fields of science. For example, the respondents were asked to identify whether particular statements were correct (e.g., the sun goes round the earth and electrons are smaller than atoms). Another element of investigation regarded the knowledge of the concept of "theory" (e.g., whether Einstein's theory of relativity is an idea, a well established explanation, or a proven fact).

Ironically, while various researchers argue that it is important for the public to understand science, the surveys by Durant and colleagues (1989) suggested a sign of the public ignorance of science. While the majority of the respondents showed a moderate level of interest in science, their performance on factual scientific knowledge was unsatisfactory (averaging only 11 correct items out of 20 questions). In addition, the result revealed that the respondents that identified themselves as very interested and very well-informed tended to be better educated and have a higher score on objective scientific understanding.

This situation of a scientifically illiterate citizenry mainly demands increased efforts in science education because of the belief that poorly informed people are implicitly disqualified from participating in policy decisions with scientific context (Bauer et al., 2007). This so-called deficit model adopts a one-way, top-down

communication process that relies on scientists to educate scientifically illiterate citizens. By conveying scientific information to citizens through school education and the mass media, it is expected that the public's scientific understanding would be enhanced. However, based on longitudinal surveys conducted in both the US and the UK, Miller (2001) argues that adult scientific literacy has not significantly improved after years of education efforts.

After reviewing a substantial body of the American national survey regarding the public understanding of (and attitudes about) science and technology from 1957 to 1999, Miller (2004) found that while the proportion of scientifically literate citizens in the US has increased over the past two decades, the overall level is still inadequate (only 17% of Americans qualified as scientifically literate in 1999). However, most Americans have expressed a positive attitude toward science and technology by showing a high degree of interest in new scientific and medical discoveries and holding to the belief that science and technology are important and beneficial in their daily lives in terms of making life healthier, easier, and more comfortable (Miller, 2004). Miller (2004) argues that despite the majority of scientifically illiterate citizens, the interest and belief in science and technology is embedded in American culture.

While continually measuring the public's overall level of scientific knowledge, a second paradigm predicted the public understanding of science shifts the research emphasis to public attitudes toward science and technology and the relationship between attitudes and knowledge. The concern about potential public negative attitudes toward science emerged prominently in the US during the mid-1980s—in the wake of a series of hazardous events (e.g., the Three Mile Island accident, the Love Canal incident, and the

Bhopal explosion). The primary research question during this time centered on investigations of the expectation “the more you know it, the more you love it” (Bauer et al., 2007).

Allum et al. (2008) analyzed the presumed linear relationship between public attitudes and public knowledge about science and technology across forty countries during the period from 1989 to 2004. The result revealed a positive but weak correlation between these two variables. Nonetheless, while people that are more scientifically literate tend to endorse more positive attitudes toward science in general, they are not necessarily more positive about some controversial issues in specific technological applications (e.g., agricultural biotechnology, and genetically modified food).

Both the scientific literacy paradigm and the public understanding of science paradigm are based on a deficit of public comprehension and an emphasis on education and communication to enhance lay scientific knowledge and attitudes. The final paradigm is grounded in the relationship between science and society and shifts the focus from the deficit of scientific and technological institutions and expert representatives to an approach based on public engagement (Bauer et al., 2007). A number of qualitative research studies of deliberative activities (e.g., citizen juries, hearings, and consensus conferences) have been conducted not only to discover the relationship between the lay public and science (i.e., scientific institutions and scientists), but also to attempt to explore the underlying social and cultural factors that influence people’s scientific understanding (e.g., Seargent & Steele, 1998; Rowe & Frewer, 2004; Rowe et al., 2005).

Interestingly, the democratic argument for the public understanding of science is that scientifically literate citizens would be more prepared to take part in important

personal and societal decisions. However, Turney (1996) argues that it should be the other way around: if people see an opportunity to participate, then they would be more willing to understand science. He found that while none of the lay participants in the UK Consensus Conference on plant biotechnology knew about the subject, they were willing to study technical information from the experts during weeks of preparation because they knew their opinions would shape the report of the conference.

### *Critiques of Standardized Instrument of Scientific Literacy*

Bauer et al. (2007) discusses several problems regarding the standardized measurement approach to assess public knowledge, interest, and attitudes about science. The first problem that this group of authors identifies is the vague definition of essential scientific knowledge. What counts as science is variously defined by different people and even by the same people under different circumstances (Ziman, 1991). While Miller (2001) suggests that citizens need to be able to comprehend science-related news articles, Durant and colleagues (1989) assert that citizens need to know only elementary level scientific facts. In reality, not everyone has access to *The New York Times*, and the reason why some adults are not smarter than fifth graders may be simply because they forgot elementary knowledge which may lack day-to-day relevance (Miller, 2001). As Turney (1996) observed, people ignore science because they tend to view the bulk of scientific knowledge as simply irrelevant to their needs and interests. Therefore, there is apparently a gap between what people think they need to know and what scientists assume people need to know.

Miller (2001) argues that traditional factual communications have little lasting effect on knowledge levels—people tend to receive knowledge, use knowledge they need,

and then forget it. As discussed earlier, the practical reason for the public to understand science is predicated on the claim that science-based technologies affect everyone's lives. Miller (2001) contends that the social application aspect of scientific knowledge (e.g., boiling water will kill viruses, but antibiotics will not) may be more needed and relevant to real life for citizens than knowing an electron is smaller than an atom.

This point directly leads to the second problem of the measurement of scientific knowledge. To measure the level of scientific literacy in general, these surveys usually use a composite scale that may be constructed using items derived from various scientific disciplines. For example, Miller (1998) constructs the understanding of science and technology with four aspects (i.e., molecule, DNA, radiation, and the nature of the universe). Miller (2004) found great variations in Americans' understanding across these different scientific domains. Nearly 50% of American adults correctly understand that the earth rotates around the sun while only approximately 10% correctly understand the concept of radiation (Miller, 2004).

It seems inevitable that some people will be more familiar about certain fields, and others will be more knowledgeable about other scientific issues. This situation means that it is unlikely that people can know it all. As a result, the specific scientific knowledge presumed as essential and chosen by scientists to measure may directly influence the outcomes of these surveys on scientific literacy. In addition, while the measurement is supposed to be interpreted in combination, it is common for public speakers and the mass media to manipulate the implications by citing single items (Bauer et al., 2007).

Moreover, although the Oxford scale showed reasonably strong reliability in Durant et al.'s (1989) study in the US and UK, Pardo and Calvo (2004) argue that the

scale is deficient in terms of its reliability in cross-cultural equivalence. Because every country has different scientific priorities and science-education systems, it is problematic (and nearly infeasible) to have a fair and universal indicator of scientific literacy for cross-cultural measurement and comparison (Bauer et al., 2007).

Finally, the original concept of scientific literacy is a threshold measure. Miller (2004) argues that an individual needs to have “some” minimal level of literacy and be interested in and have positive attitudes toward science and technology to be qualified as a scientifically literate citizen ready to participate in political decisions. However, the threshold and the standard are difficult to determine—how high does one need to score to be considered as literate? Is correctly answering half of the items on a test of scientific facts sufficient? In addition, as Miller (2004) points out, 17% of adults in the United States qualified as scientifically literate in 1999—a level that is approximately equal to citizens in the UK, France, Denmark, and the Netherlands. If this level is still considered to be insufficient, what proportion of scientifically literate citizens should a society aim to achieve?

### *Critiques of the Deficit Model*

Because the surveys conducted by Durant and colleagues (1989) revealed the finding of a scientific illiterate citizenry, proponents of the various deficit models demanded more education to improve the public’s scientific knowledge. The civil education approach has attracted a great deal of attention and discussion over the past decade among scholars and policy makers concerned about science education policy (Miller, 2004; Bauer et al., 2007). However, Miller (2001) found that despite enhanced education and communication, adult scientific literacy has not been significantly improved. Apparently,

the educational focus on factual scientific knowledge has failed to effectively diminish the gap of insufficient scientific understanding. The following discussion illustrates a number of critiques of the deficit model.

First, Irwin et al. (1996) contend that the traditional narrow framework based on scientists' assumptions of essential scientific knowledge neglects preexisting lay knowledge. As discussed in Subsection 2.2.3, scientific knowledge has expanded from objective, homogeneous, and value-free facts to a broader sense that is diverse, heterogeneous, and policy-relevant. The high level of complexity, uncertainty, and controversy of a variety of risk-related problems in the modern society (e.g., genetically modified crops and environmental pollutants) requires various branches of science to work together with non-scientific organizations. As a result, lay knowledge can in some instances be as significant as expert-presumed scientific knowledge.

In addition, this top-down, one-way education model often limits the sources of information available to the public and selects certain forms of knowledge that are seen as privileged and legitimate (Irwin et al., 1996). Based on studies of local pollution and hazard issues, Irwin and his colleagues (1996) argue that there is a need for more than one source of technical information and a requirement for interactive communication processes rather than a singular didactic process. It is important to know where and from whom citizens receive their information about technical matters because different sources or interest groups give rise to different public understandings.

Finally, Turney (1996) found that public ignorance does not necessarily mean that the public is lacking knowledge. In a famous case involving radiation workers in a nuclear reprocessing plant, Wynne et al. (1990) found that even though these individuals

seemed to need to understand the science of radiation risks for their own health benefit, they resisted receiving such information. These workers justified their ignorance on their interpretation that they did not need to confront endemic uncertainties and they trusted that there were specialized experts in the company to protect them. Wynne (1995) argued that people do not necessarily see the need or express the interest to know more when they think the potential problems are under the control of trusted scientific expertise.

Failure to improve adult scientific literacy has demonstrated that the deficit model (i.e., addressing the problem of scientific insufficiency with civil education) oversimplified the problem. It appears that public ignorance of science involves more underlying social-institutional considerations (e.g., trust in institutions and scientists) than simply the issue of inadequate scientific knowledge. Therefore, more in-depth studies are required to investigate the relationship between science and the lay public and to explore how the engagement of scientists and citizens would help policy makers to address controversial environmental problems in a variety of participatory practices.

### *Integration of Science and Citizens*

The dynamic relationship between science and citizens has been a key focus of inquiry not only for scholars working on the public understanding of science, but it has also animated the efforts of policy makers interested in public participation practices. While Beck's (1992) notion of the risk society captured the public's concern about increasing risks in techno-industrial modern society, the privileged status of science and the benefit of science and technology were also challenged during this same general time period. For example, environmental groups began to employ counter-expertise to combat the "official" science deployed by industry and regulatory agencies (Yearley, 2000).

In addition, the emergence of an increasing number of highly complex and uncertain problems related to health and the environment attracted the public's attention (e.g., bovine spongiform encephalopathy (BSE), hazardous industrial wastes, and agricultural biotechnology). To address these controversial issues has required the public's involvement in formulating public policies. For example, the *Science and Society* report published in the UK by the House of Lords (2000) not only proposed broader public participation in science policy, but also suggested that the process of engaging the public should become a normal and integral part of the policy-making process.

However, the scientific literacy studies discussed earlier showed the existence of a perceptual gap with respect to scientific knowledge between privileged scientific experts and the general public. Durant (1995) referred to the relationship between scientists and citizens using the doctor-patient metaphor—"cautious skepticism is simply what any sensible person is inclined to exercise when dealing with professionals who have the kind of power that doctors have over their patients' lives." The point he raised was that trust and public discontent with expertise had become key issues in the public understanding of science. Therefore, he argues for a shift in the public understanding of science research to explore more fully how the public engages with science (Durant, 2008)

Science shops and consensus conferences have been developed in an attempt to bridge the gap between scientific expertise and lay perspectives (Gregory & Miller, 1998). First, the concept of science shops was pioneered in the Netherlands during the 1960s and later spread to other European countries over the following decade. It was found at the time that a variety of social groups (e.g., students and non-governmental organizations) had limited (or even no) access to scientific knowledge. Therefore, universities

established science shops or specialized research centers to provide opportunities for the public (scientifically disadvantaged social actors) to gain access to scientific insights and expertise (Irwin, 1995).

While the science shops served various client groups (e.g., environmental groups, trade unions, and welfare workers), they tended to get involved only in projects that met at least one of the following criteria: 1) the client group had no money to pay for research; 2) the project had no commercial motives; 3) the project was in a position to implement the results for some practical purpose (Irwin, 1995). However, some of the non-profit and service-oriented Dutch science shops were closed down in the late 1990s for various reasons including changes in the political climate, financial cutbacks, reorganizations in Dutch higher education, and the professionalization of action groups (Wachelder, 2003).

To withstand these financial constraints and the problems of marginalization in the university system, Fischer et al. (2004) argue that science shops need to adapt their strategies to the changing environment in several ways, namely by establishing political coalitions (from grassroots movements to policy making), building up an international knowledge network, engaging in commercially profitable projects, and obtaining public support in new social movements.<sup>22</sup>

Second, consensus conferences, pioneered by the Danish Board of Technology in the 1980s, constitute a tool of deliberative democracy—engaging the public in political decision making with reasoned discussions (Blok, 2007). Since this time, approximately 50 consensus conferences have been organized throughout the world (e.g., Australia,

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<sup>22</sup> For instance, the science shop in Bonn has engaged in commercial activities by selling career counseling and job-seeking help in the social and ecological field. However, science shops need to be aware of the potential conflicts of interests between social goals and commercial goals (Fischer et al., 2004).

Japan, the US, the UK) for a variety of controversial issues (e.g., biotechnology, medicine, or the environment) (e.g., Guston, 1999; Purdue, 1999; Einsiedel et al., 2001; Brown et al., 2004). Two primary goals of these events have been 1) to provide decision makers with the information resulting from the conference and 2) to stimulate public discussion through media coverage of both the conference and follow-up debates (Fischer, 2003a).

This participatory process for an effective consensus conference takes months of preparation and involves numerous political actors (e.g., politicians, scientific experts, and citizens). Approximately 20 interested citizens with mixed socio-demographic characteristics are recruited and required to attend several weeks of preparatory meetings during which they need to study information from expert presentations and technical reports. At the official conference, usually lasting three to four days, the participants are intellectually capable of interacting with panels of experts and of engaging in substantive discussions with fellow participants. The conferees then prepare a consensus report and that is presented publicly to various stakeholders and decision makers (Fischer, 2003a).

The conclusion of the conference clearly reflects the concerns of the population more than the traditional expert assessments. Moreover, the recommendations made by the participating citizens have successfully influenced the Danish Parliament on a number of environmental policies, namely opposing funding on animal gene technology research and accepting a tax on private vehicles (Fischer, 2003a). In addition, the conferees demonstrated increased knowledge of the subject and felt more confident in their ability to address technical issues generally (Joss, 1995). However, the cost of organizing consensus conferences is high in terms of time, money, and effort and these factors may be sources of concern if a pending decision is urgent (Fischer, 2003a).

Although these two mechanisms engage scientists and the public in different ways—science shops for grassroots movements and consensus conferences for policy making—it is interesting to find that the role of scientific experts in both practices are somewhat similar. Scientific experts act as assistants and service-providers who supply scientific information to the general public—who may have difficulty accessing science on their own. In addition, the relationship between the scientific experts and citizens in both settings shifts from the traditional top-down model of educators and receivers to working as side-by-side partners. Most important of all, the scientific information delivered in both models is the knowledge the public needs for their everyday dealings with science and technology and for making informed decisions (Irwin, 1995)

However, the participatory approach is a challenge for policy makers because of the high cost (i.e., time, money, and effort) and the difficulty assessing the effectiveness of such deliberative activities. In addition, while policy makers often expect that the participatory activities will serve as a means of public persuasion, the outcome does not always turn out as expected. For example, the British public was still not convinced of the benefits of genetically modified crops and food products after the national *GM Nation* debate in the UK in 2003 (Bauer et al., 2007). One possible response was to conclude that further dialogue was needed until the public had inculcated the “right” attitude. Nevertheless, the key question is whether political and scientific institutions are prepared to accept the public’s informed decision even if it runs counter to their prefigured expectations. Otherwise, a situation is created whereby the dialogue and deliberation will not stop until the public renders the decision that the policy makers expect.

### Summarized Review

In brief, it is generally agreed that it is essential for the public to have a better scientific understanding in modern techno-industrial democratic society than is currently the case. The traditional deficit model assumes a public state of deficiency: citizens lack either enough or the right kind of knowledge, and thus fail to display sufficiently positive attitudes and do not make informed decisions. The limited improvement in scientific literacy among citizens after decades of civil education has become manifest that the public's level of scientific knowledge is not solely influenced by the extent of information exposure—the receipt of more information does not mean we know more.

Moreover, while the public may have inadequate scientific knowledge, scientists display incapacity to appreciate lay and experiential knowledge. These ordinary perspectives are crucial in policy making because the realm of working scientific knowledge has expanded from one of homogeneous and objective facts (provided by scientist) to an assembling of multidisciplinary viewpoints (constructed by a variety of societal actors). As a result, a diverse number of public engagement practices have been developed to bridge the relationship between scientists and citizens. These mechanisms are designed to create opportunities for mutual learning experiences for both scientists and citizens so that not only the public understands science, but also scientists understand the public.

#### **2.2.6 Concluding Remarks**

Given the diverse issues on the contemporary political agenda, environmental problems tend to be viewed as especially difficult for policy makers to manage (Carter, 2001). Because of increasing environmental threats in modern techno-industrial society, the

information requirements for policy makers and the general public have expanded from an exclusive focus on objective scientific knowledge (realists) to multidisciplinary scientific perceptions (constructivists). Thus, Dryzek (1997) argues that the citizen-driven democratic approach is a more effective mechanism than the expert-driven administrative approach for solving complex environmental problems in democratic governance.

This participatory framework emphasizes deliberative interactions by involving a wider range of interests in the policy-making process. However, to ensure the quality of the deliberations and the effectiveness of resulting policy decisions, it is essential to build the intellectual capacity of citizens—enhancing the public understanding of science. Acting as communicators, scientific experts may be a significant information source for the public. However, the traditional deficit model that relies exclusively on an education approach to improve scientific literacy has been judged to be a problematic oversimplification.

In addition to the extent of scientific knowledge, there are underlying social and cultural factors that influence the public's scientific understanding. In an effort to bridge the relationship between scientists and citizens and to involve multiple perspectives in the policy-making process, a number of participatory practices have been developed to encourage the public to acquire necessary scientific information and to let scientists and policy makers understand the perspectives of lay citizens.

## 2.3 Sociological Studies of Climate Change

### 2.3.1 Introduction

Global climate change's anthropogenic causes, adverse impacts on human society, and potential solutions are connected to each individual on the planet at various degrees. It is a profound challenge for environmental sociologists to understand how human beings perceive, respond, and expect to resolve this complex global environmental problem. In addition, as discussed in Section 2.2, to integrate scientific and lay perspectives into the environmental policy-making process in modern techno-industrial societies, it is essential to enhance societal understanding of science. Social scientific research has in recent years been playing a role to integrate these domains (i.e., science, citizens, and politics) and to bridge the different appraisals of laypeople and scientific experts. It is accordingly also a critical challenge for environmental sociologists to explore how these three domains influence and interact with each other.

This section examines recent findings from sociological studies of the public understanding of climate change. Subsection 2.3.2 highlights the rationale of the relationships among attitudes, knowledge, and behavioral intentions from a social psychological perspective. Subsection 2.3.3 reviews the evolution and the context of public perception of climate change since the 1980s. Subsection 2.3.4 discusses the public's scientific knowledge and misconceptions regarding climate change.<sup>23</sup> Subsection 2.3.5 examines several participatory practices that have engaged citizens in the development of climate policies. Subsection 2.3.6 concludes this section.

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<sup>23</sup> This paper defines “perception” as general concern and awareness—people’s initial impression about climate change. In contrast, “understanding” is defined as in-depth scientific knowledge that includes comprehension of causes, consequences, and responding strategies. Therefore, the review is separated into two subsections.

### **2.3.2 Theoretical Relationships of Attitudes, Knowledge, and Behaviors**

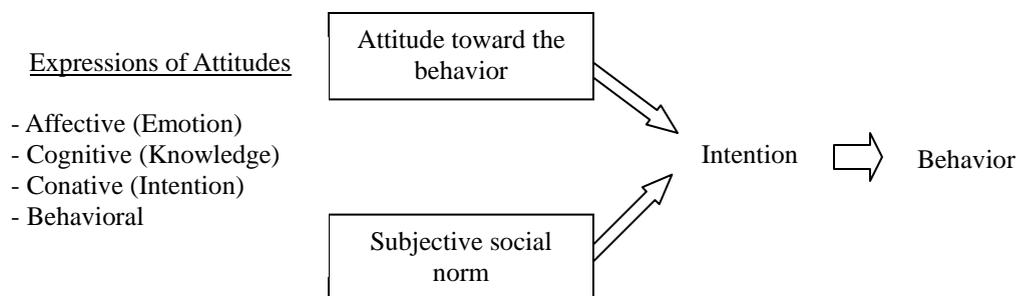
Dietz and Rosa (2002) argue that environmental sociologists need to “work at both the local and global, or micro and macro levels, and especially at the meso level that seeks to link phenomena at these two levels to understand the human dimensions of global change.” Such an observation suggests that it is of particular interest to explore how people at the local level view and interpret this global problem and how they conceive of the responses being mobilized by various institutions (e.g., governments, corporate, and civil society organizations).

Rosa (2001) further asserts that “sociology has approached the global climate change problem from opposite ends of the epistemological spectrum: an interpretive, social constructivist perspective (von Storch & Stehr, 1997) and an ecological, scientific perspective (Dietz & Rosa, 1997).” The first perspective has centered on exploring key factors that shape public understanding of climate change through the assimilation of scientific claims-making. The second perspective has focused on scientific and policy issues such as the modeling of human sources of CO<sub>2</sub> buildup (Dietz & Rosa, 1997) and the societal impact assessment of carbon policies (Krebill-Prather & Rosa, 1994).

In accordance with the social constructivist perspective, Dietz and Rosa (2002) contend that two major issues emerged in environmental sociological research on climate change: 1) understanding public perceptions and concerns and 2) examining human responses to those perceptions (e.g., individual decision making at a micro level, and organizational and state responses at a macro level). Moreover, a particular emphasis worthy of study has been the relationship between public comprehension and its responses—how people’s concern stimulates their actions to combat climate change.

While scientific research on global climate change originated during the 1950s, the issue did not begin to attract popular attention until the 1980s. Since then social scientists have applied considerable effort to measuring people's concerns about various climate-related issues. Dunlap and Jones (2002) argue that public concern is often conceptualized and investigated through two approaches: a theoretical approach and a policy-relevant approach (see Section 4.5). Based on attitude theory (Maloney & Ward, 1973), the theoretical approach investigates the knowledge of respondents in terms of the nature of beliefs, attitudes, intentions, and behaviors and the theoretical and empirical relationships at a micro or individual level from a social psychological perspective.

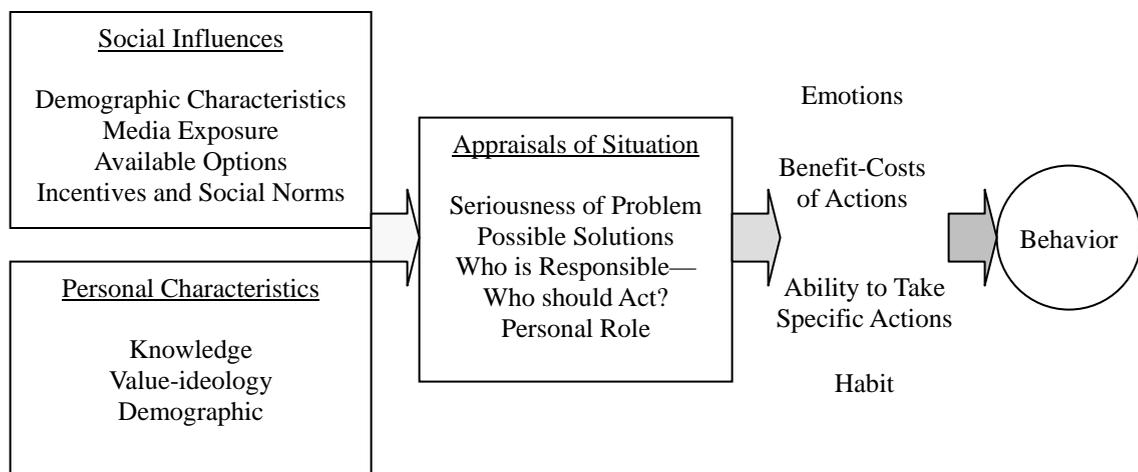
The aim of this work is that by collecting data on public concerns and attitudes about climate change it might become possible to predict how the public will act. Figure 2.2 shows the basic structure of attitude-behavior theory (Ajzen & Fishbein, 1980). A person's beliefs and societal performance expectations determine how s/he will act and, in turn, perform certain behaviors. Dunlap and Jones (2002) argue that these attitudes are generally presented in four ways: affective (i.e., emotion or feelings), cognitive (i.e., relevant knowledge), conative (i.e., intention or commitment to act), and behavioral (i.e., actual or reported actions) expressions.



**Figure 2.2** The attitude-behavior theory and the expressions of attitudes.  
Source: Ajzen and Fishbein (1980); Dunlap and Jones (2002)

Various inquiries have used different models to examine which factors determine a person's environmentally relevant behaviors and to investigate how these factors associate with each other. For example, Krosnick et al. (2006) use the so-called ACE model to determine the seriousness of a respondent's judgments about global warming with variables such as Attitudes toward consequences, Certainty, and Existence beliefs. In addition, Leiserowitz (2006) argues that the general public's risk perceptions and policy support are determined by a variety of psychological and socio-cultural factors (i.e., affect, imagery, and values).<sup>24</sup>

Patchen (2006) integrated several theoretical models and created a comprehensive model to determine behaviors relevant to climate change.<sup>25</sup> He argues that individuals are influenced by various social forces and personal characteristics and accordingly evaluates his/her situation by making a preferred choice based on four motives: emotional concern, benefit-cost analysis, personal capability, and personal habit (Figure 2.3).



**Figure 2.3** Patchen's model of the determinants of behavior relevant to climate change.

<sup>24</sup> Affective images refer to people's positive or negative feelings for specific visual or symbolic impressions of climate change. Values include worldviews of social relations such as hierarchical, fatalistic, individualistic, and egalitarian (Leiserowitz, 2006).

<sup>25</sup> Figure 2.3 does not indicate detailed associations among factors in Patchen's study.

On the basis of a comprehensive review of relevant studies, Patchen (2006) identifies two reasons that drive people to take actions to preserve the environment and to combat climate change. The first reason, originated from the utilitarian concept, is the rational judgment of “net benefit”—the merits outweigh the costs of actions. The other reason, based on emotional concern, is the fear of being threatened by climate-change impacts. In addition to the introduction of messages that focus on these two reasons, he argues that it is essential to inform people about their shared responsibility for the problem and about specific actions that they can take to tackle climate change.

A key concern discussed by Patchen (2006) was the judgment of seriousness of climate change. Krosnick et al. (2006) conducted a nation-wide telephone interview study in the US during 1997-1998 to investigate the factors that may influence people’s perception of the seriousness of global warming. The result revealed that individual seriousness about the problem is an interactive function of existence beliefs, attitudes, certainty, and beliefs about human responsibility and policy effectiveness. In other words, people who believe that human-induced global warming exists and causes adverse consequences with a high certainty will likely regard climate change as a serious problem and support robust climate policies.

These beliefs are influenced by a variety of factors. Existence beliefs depend on whether people have relevant personal experiences with relevant real-world conditions, whether they have trust in scientists and have cognitive skills to judge, and their exposure to relevant news media messages. Attitudes toward climate change depend on how people perceive and evaluate particular consequences. Finally, certainty is influenced by people’s knowledge and perceptions (Krosnick et al., 2006).

A variety of external factors appears to influence an individual's attitudes toward climate change when appraising his or her situation (Patchen, 2006). According to many national surveys and opinion polls conducted over the course of the past two decades, general public awareness toward global climate change has increased considerably since 1988 (Lorenzoni & Pidgeon, 2006). At the same time, some researchers have described fluctuations in public concern and interest in the issue. Ungar (1992) argues that the public's attention has tended to be attracted and catalyzed by real-world events. An example of this phenomenon is that while scientific evidence of global warming had existed for some time before 1988, it was the unusually hot and dry summer that year in the US that first mobilized vigorous social attention around the issue and first ignited public anxiety in the country.

In contrast, Krosnick et al. (2000) discovered in the surveys conducted before and after the 1997 Kyoto Conference that although the international debate about the resultant Protocol attracted popular attention and strengthened existing beliefs and attitudes, no significant changes could be discerned in public opinion about climate change. Ungar (2000) argues that global climate change lacks the currency and day-to-day relevance necessary to motivate individuals to obtain information. This observation is relevant in helping to understand why public interest in climate change has fluctuated over time.

In addition to the occurrence of real-world events, another factor influencing the public's variable attention span and perception is media coverage—how the issue is reported by journalists and interpreted by readers (e.g., Harrison, 1982; McComas & Shanahan, 1999; Corbett & Durfee, 2004). For example, balance, a cherished journalistic norm, can contribute to informational bias in the case of climate change (Boykoff &

Boykoff, 2004; 2007). An analysis of so-called prestige-press coverage of global warming in the US from 1988 to 2002 revealed that although the international scientific community had by that point reached a consensus on the anthropogenic contributions to global warming, the majority (52.7%) of coverage in the US gave roughly equal attention to two views: anthropogenic causes and natural fluctuations (Boykoff & Boykoff, 2004).

Boykoff and Roberts (2007) analyzed forty English-language newspapers during 1988-2006 in seventeen countries including the US, the UK, Japan, and Australia. The result revealed that coverage of climate change/global warming and adaptation has been lower outside of Europe and North America. Moreover, this reporting was often comprised of “second-hand” news stories reproduced from Europe and North American sources. A separate quantitative analysis of newspaper coverage of climate change in the US and UK by Boykoff and Rajan (2007) found that the number of news articles in both countries has increased significantly since 2006, and they attribute this effect to the publicity that former Vice-President Al Gore generated with his film *An Inconvenient Truth*.

In brief, one research emphasis for environmental sociologists has been to investigate people’s beliefs, attitudes, intentions, and behavioral intentions from a social psychological perspective. In addition to external social influences, one key personal characteristic that appears to shape an individual’s attitudes and influences is his or her knowledge-appraisal process. This factor is closely related to the key inquiry of this doctoral research—how scientific understanding may help the public take actions to combat climate change. The next two subsections review the general public’s perceptions and scientific understanding of climate change.

### 2.3.3 Public Perception of Climate Change

Enhancing public awareness of climate change is considered to be a prerequisite for galvanizing successful grassroots movements committed to changing individual behaviors and putting pressure on governments to formulate effective policies. This discussion primarily highlights the findings from a study by Nisbet and Myers (2007) that compiled the results of over 70 polls and surveys over the past two decades.<sup>26</sup> Findings from numerous survey and focus-group studies are also included in the analysis. The content of the public's perception was analyzed in several aspects (e.g., initial awareness, beliefs in the reality of climate change, and risk perception).

#### Public Awareness of Climate Change

Before exploring the context of what the public thinks of the issue of climate change, it is reasonable to understand their basic impression—do they even know about the issue? This is why the most simple and commonly-used indicator in early public opinion polls and surveys of a person's level of awareness of climate change was to ask respondents "Have you heard or read anything about the greenhouse effect, global warming, or climate change?" Nisbet and Myers (2007) found that most of the American public was not aware of the issue until the record-breaking hot summer of 1988. Only 39% of the respondents in 1986 had heard about the greenhouse effect. The percentage increased to 58% in 1988 and grew to over 80% in the 1990s, and 91% in 2006.

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<sup>26</sup> The public polls and surveys compiled by Nisbet and Myers (2007) have respondents of nationally representative adult samples with sample size of approximately 1,000 or more. The data sources include a variety of survey agency, news organizations (e.g., Gallup Organization, Cambridge Reports, ABC News, the Pew Research Center). While citing data from Nisbet and Myers (2007), this chapter does not specifically reference the original survey sources in the references.

*Belief in the Reality of Climate Change*

One of the most important concerns is whether or not the public believes that climate change/global warming caused by the enhanced greenhouse effect is a “real” issue with the level of severity that necessitates concern and response. According to Nisbet and Myers (2007), 68% of the American public in 1992 believed in the reality of the issue. Since then an increased percentage of Americans has been convinced that the world’s temperatures have risen, ranging from 72% in 2000 to 84% in 2007.

However, with the increased scientific confidence that accompanied publication of the IPCC’s fourth assessment report in 2007, why would some people still have doubts on the reality of global climate change? Leiserowitz (2006) discusses five reasons why people may deny the reality of global climate change: 1) the belief that global warming is a natural course of events; 2) the belief that the problem is exaggerated by the media; 3) the belief that the scientific evidence is insufficient; 4) the belief that global warming is a false theory; 5) the belief that the problem is made up by some conspiracy theories.

Nisbet and Myers (2007) also discover that while most Americans are affirmative that the phenomenon is happening, they are less certain about scientists’ position on the issue. Despite slightly different questions and phrases from various surveys, not many respondents believe that there is a consensus among scientists on the issue, ranging from 28% in 1994 to 40% in 2007. In addition, only 32% of the respondents in a 2007 poll answered that they trust scientists on the issue of environment “completely” or “a lot” while 43% trust them moderately and 24% trust them “little” or “not at all.” Thus, Nisbet and Myers (2007) argue “trust in scientists likely remains a factor in perceptions of the scientific evidence relative to global warming.”

The Pew Research Center (2008a) conducted a poll (n=1,502) in April 2008 and found that while most Americans (73%) believed that global warming is a serious problem, only 47% thought it was caused by human activities. Similar to the contradictory result in the US, a poll (n=1,039) conducted by Ipsos MORI in the UK in May 2008 revealed that while a majority of British respondents (77%) were concerned about climate change, 60% still doubted that climate change is induced by humans (Ipsos MORI, 2008).

### *Public Risk Perception of Climate Change Impacts*

Although the majority of the public in the US believes that climate change is real and occurring, people are less certain about the role of anthropogenic forces. This conception is likely influenced by a perception that deep disagreements continue to exist among scientists (Nisbet & Myers, 2007) and by informational bias from ostensibly balanced media coverage (Boykoff & Boykoff, 2004). Moreover, the public's expression of worry about climate change is affected by how people perceive the immediacy of impacts related to climate change. This is an important point because lay risk perceptions may influence the resultant sense of urgency to take mitigation actions. If people do not feel climate change is dangerous and do not feel threatened, why would they feel compelled to take any actions?

Peters and Slovic (2000) argue that this negative affect would drive people to make a change in order to remove themselves from the dangerous situation and lessen their feeling of being at risk. Weber (2006) argues that two approaches that can establish a person's risk perception and trigger his/her reactions include 1) experiencing adverse consequences personally and 2) receiving statistical information of adverse consequences

from experts. On one hand, even though some extreme weather events occasionally happen these days, one challenge to experience-based reactions is the relatively small likelihood of seriously adverse impacts for most people in the current generation.

On the other hand, the challenge for the second approach is the potential conflict between subjective risk perceptions and objective risk assessments provided by scientists. Without one of these two interventions (i.e., personal experiences and statistical description), people will fail to pay attention and to allocate resources to moderate climate-change risks. However, decision makers need to be cautious when employing these interventions to enhance the public's risk perception of climate change because it may compromise their concern about other important risks (e.g., hazardous waste exposure) (Weber, 2006).

Although there is a growing consensus among climate scientists about the anthropogenic influences and the potential adverse impacts of climate change, the exact effects (i.e., when, where, and at what degrees will these impacts happen) remain uncertain. Oppenheimer (2005) argues that even though natural scientists have done their best to quantify their assessments and to estimate future scenarios, there are apparently limits on the extent to which science can define climate "danger."

Take the disintegration of the major ice sheets as an example. There are still uncertainties about how much warming will occur, how much ice will melt, how much sea-level will rise, and when these changes will happen. Even if there is a perfect computer model that can project the scenario with countless variables, the model cannot assess how dangerous the collapsed ice sheets are for different people (Oppenheimer, 2005). Thus, Oppenheimer (2005) argues "social science may also make important

contributions by helping policy makers understand the way in which values arising from cultural and ethical considerations ought to contribute to determining the final outcome.”

A Gallup poll (n=1,012) conducted in March 2008 revealed that while 61% of Americans recognized that global warming has already begun, only 37% worried about the problem (in comparison to 35% in 1990) and only 34% thought additional, immediate, and drastic actions were necessary (Gallup, 2008). This perception may be caused by the fact that only less than half of Americans believed that global warming would pose a threat to them in their lifetime, ranging from 25% in 1997 to 33% in 2002 to 40% in 2008 (Nisbet & Myers, 2007; Gallup, 2008).

Nisbet and Myers (2007) found that the percentage of Americans who worried a “great deal” about global warming fluctuated during the course of the past two decades, ranging from 35% in 1989 to 24% in 1997 to 41% in 2007 (in the aftermath of the release of *The Inconvenient Truth*). The level of concern about global warming was significantly lower compared to other environmental issues, especially water-related pollution issues. For example, a total of 58% of Americans worried a “great deal” about drinking polluted water.

Based on a nation-wide survey conducted during 2002-2003, Leiserowitz (2006) found that Americans perceived global climate change as an issue that carried moderate risk. Interestingly, a total of 68% of the respondents were most concerned about the impacts on people around the world and non-human biological community, compared to 13% who were concerned about the impacts on themselves, family, and the local community, 9% were concerned about the impact on the US, and 10% were not concerned at all. Due to the perception of lower personal and local relevancy, Leiserowitz

(2006) argues that the moderate level of concern may explain why global warming has been placed in a lower political priority.

Based on two national surveys conducted during 2002-2003, Lorenzoni et al. (2006) compared the affective images of climate change among the British and American publics. The respondents were requested to identify three images coming up in their minds regarding climate change and to rate the affect toward the images (positive or negative). The study reported that while the British and American publics shared several impressions (e.g., flood, sea level, and changing climate), they had some different perceptions.

For example, the British respondents were more sensitive to the images: “ozone,” “pollution,” “weather,” “greenhouse,” and “rain.” In contrast, significantly more American respondents mentioned “ice melting,” “heat,” “nature,” “disaster,” and “skepticism.” In addition, the respondents in both countries felt a negative attitude toward climate change, which means they felt the problem was a bad thing. Moreover, citizens in both countries considered climate change (i.e., its impacts, causes, and solution) to be less personally relevant and psychologically distant (Lorenzoni et al., 2006).

Lazo et al. (2000) employed a quantitative survey to investigate whether experts and laypeople had different perceptions of ecosystem risks caused by global climate change in terms of various risk characteristics (e.g., understandability and controllability). While laypeople tend to presume catastrophic ecosystem impacts from climate change, they believe that scientists have sufficient understanding about the risks and that these impacts are manageable. In contrast, although experts do not perceive climate-change impacts to be significant as laypeople, they think that these risks are less understandable

and less controllable. The result suggests a need for better risk communication between climate scientists and laypeople because these two groups appear to hold significantly different risk perceptions.

*Public Support for Policy Action and the Kyoto Protocol*

As discussed above, the general public tends to view global climate change as less personally relevant and more psychologically distant. That is why global warming was ranked by Americans as a relatively low priority compared with other public issues (Pew Research Center, 2008a). Similarly, although there was a high level of concern about climate change, Poortinga and Pidgeon (2003) found in a 2002 British survey that people tended to place their main priorities on other personal issues such as health, family, and safety.

This conclusion corresponds quite closely with two other surveys carried out in the UK in 2004. By this point in the political evolution of the issue, most people had heard about global warming and viewed it as the most important environmental issue of the day, but they considered terrorism and domestic issues as higher priorities (Norton & Leaman, 2004; Kirby, 2004). A total of 68% of the British people in 2008 wanted the government to do more on the issue of climate change, but 59% questioned the government's underlying motivation—to raise taxes (Ipsos MORI, 2008).

Leiserowitz (2006) found in the 2002-2003 survey that Americans demonstrated a contradictory mentality toward climate change risk perception and policy preferences. Even though the American public expressed moderate levels of concern about the issue (largely because they did not think climate change would impact them), 90% of the respondents thought that the US should reduce its GHG emissions.

In addition, the majority of Americans supported the Kyoto Protocol (88%) and expected the US to reduce its GHG emissions regardless of what other countries did (76%) in the 2002-2003 survey (Leiserowitz, 2006). Nisbet and Myers (2007) found a similar result—64% in 2002 and 73% of Americans in 2005 thought the US should participate in the Kyoto Protocol to reduce global warming. Interestingly, when the survey provided President Bush’s argument for withdrawing from the treaty—the treaty places too much of an economic burden on the US while demanding little of developing countries, the public had a slightly different response. The 2001 Gallup poll revealed that while the majority of Americans disapproved of President Bush’s decision (ranging from 48% to 51%), there were a significant number of people accepted his argument (ranging from 32% to 41 %) (Nisbet & Myers, 2007).

Furthermore, while most Americans supported a variety of GHG emission-reduction policies at the national level, they opposed tax policies that would directly affect them (Leiserowitz, 2006; Nisbet & Myers, 2007). Leiserowitz (2006) found that over 70% of the American public supported policy actions on increasing vehicle-emission standards, regulating CO<sub>2</sub> as an air pollutant, and shifting subsidies from the fossil-fuel industries to the renewable energy industries. Support for a market-based emission trading system was divided evenly (40% in favor; 40% opposed; 18% unsure).

Nisbet and Myers (2007) concluded with similar findings from a 2007 Gallup poll. A total of 79% and 84% of Americans favored the initiatives that set higher emission standards for automobile and for industries. In addition, 81% of Americans supported proposals to develop solar and wind power and to impose mandatory controls on GHG

emissions. Nonetheless, although the public was strongly in favor of increased investment in solar and wind energy, the support on expanding nuclear energy was split (50% in favor and 46% opposed). Moreover, compared to the same poll in 2001, these opinions did not change significantly.

Interestingly, while Americans have a tendency to support policies targeting industry, they are not so enthusiastic about policies targeting households and consumers. Although a total of 54% of the respondents favored a gas-guzzler tax (Leiserowitz, 2006), approximately 80% of Americans resisted increasing taxes on electricity and 70% opposed increasing taxes on gasoline (Nisbet & Myers, 2007). This result may suggest that Americans expect the problem can be solved by someone else (e.g., government and industry), without changes in their personal behavior (Leiserowitz, 2006).

In addition, based on an ABC poll in 2007, Nisbet and Myers (2007) found that the majority of Americans prefers a voluntary approach with financial incentives rather than a mandatory approach for a variety of policy actions: reducing automobile gasoline consumption, reducing appliance electricity consumption, and reducing household and office energy consumption. The only exception is a strategy to reduce the GHG emissions that power plants are allowed to release: 62% of Americans think the government should require these facilities to reduce their releases by law.

In recent years, carbon capture and storage (CCS) has emerged as an important policy response for limiting GHG emissions. Shackley et al. (2005) investigated the public perception of CCS in the UK and his survey results revealed that a majority of the British public was not at the time familiar with this technology. The respondents viewed CCS as one part of a decarbonization strategy, along with renewable energy technology,

energy efficiency, and lifestyle change. Public support for CCS depended on three commitments: acknowledgment of human-induced climate change, recognition of the seriousness of climate-change impacts, and acceptance of the need to reduce carbon emissions. Interestingly, the level of public support for CCS slightly increased after some information was provided to the respondents.

### *Public Perception of Taking Personal Actions*

The discussion above implies that most people do not support the policy options that may directly jeopardize their benefits or lifestyles (e.g., gasoline tax policy). While mitigating climate change will likely require behavioral adjustments at some level, it is particularly interesting to examine how the public perceives its roles and responsibilities in combating climate change. Table 2.3 shows a comprehensive analysis of what the British public identified as barriers to engage with climate change at individual and social levels (Lorenzoni et al., 2007).

At social levels, the public thought that the government and industry did not make sufficient efforts toward tackling climate change and that social norms are difficult to resist (e.g., owning a vehicle is considered part of a good lifestyle). In contrast, the public identified a variety of constraints that inhibit mitigation actions. For instance, people are not knowledgeable about causes, consequences, and potential solutions to the problem. The dominant belief system in contemporary society (e.g., technocentrism and fatalism) may also restrain their actions. Lorenzoni et al. (2007) argue that there is a need for policy makers to address these concerns and to overcome people's barriers to effectively achieve reduction targets and to enable the public to shift to more sustainable lifestyles.

**Table 2.3** Public Perception of Barriers to Engaging with Climate Change

Individual Barriers	Social Barriers
<ul style="list-style-type: none"> <li>• Lack of knowledge about the causes, consequences, and potential solutions</li> <li>• Uncertainty and skepticism about the causes, seriousness, necessity and effectiveness of actions</li> <li>• Distrust in information sources (e.g., media)</li> <li>• Externalizing responsibility and blame (i.e., causes and solution) to governments and industries</li> <li>• Reliance on technology (e.g., technology will solve the problem)</li> <li>• Climate change perceived as a distant threat in space and in time</li> <li>• Importance of other priorities (e.g., family, local environmental issues)</li> <li>• Reluctance to change lifestyles because of concerns about degrading living standard, inconvenience and cost</li> <li>• Fatalism (e.g., It is too late to do anything)</li> <li>• Helplessness feeling due to the global scale of the problem</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of political action by local, national and international governments and distrust in governments</li> <li>• Lack of actions by business and industry</li> <li>• Worry about “free-rider effect” (e.g., why would I take actions if no one else does?)</li> <li>• Pressure of social norms and expectations (e.g., social status of car ownership)</li> <li>• Lack of enabling initiatives (e.g., availability of alternative choices)</li> </ul>

Source: Lorenzoni et al. (2007)

### Cross National Comparisons of Public Perception

As the prior discussion demonstrates, there have been numerous studies targeting the social dimensions of global climate change in the US and Europe. In contrast, researchers have carried out fewer inquiries on other regions of the world or investigations predicated on broad cross-cultural analyses. A poll conducted in 2008 across 12 countries by the UNEP (n=12,000) suggested that the environment remained a concern despite the financial crises and that 43% of respondents thought global climate change was a bigger problem than the economy. A total of 75% of respondents wanted their countries to reduce GHG emissions at least as much as other nations and 55% of them wanted their government to invest in renewable energy (UNEP, 2008b).

Deriving data from a 2007 ACNielsen global online survey, Sandvik (2008) investigated the relationship between public concern about global warming, national economic wealth level (i.e., per capita GDP), and CO<sub>2</sub> emissions. The result of the cross-national analysis (46 countries) ironically revealed that the willingness of a nation to commit to reduce its GHG emissions is negatively correlated to its GDP level and its share of CO<sub>2</sub> emissions. In other words, citizens of affluent nations were less concerned about climate change than citizen of less wealthy nations.

### *Youth Perception of Climate Change*

Based on a 1999 Eurobarometer survey that recruited over 14,000 respondents from 15 countries, Hersch and Viscusi (2006) argue that there are significant intergenerational differences in willingness to pay higher gasoline prices to protect the environment. The younger age groups were “more willing” to pay and were willing to “pay more” for gasoline than older age groups. This age-related difference is likely influenced by exposure to environmental risk information—younger age groups are better informed because they are more exposed to various available information sources. The result suggests that policy makers should consider the perspectives of different age subpopulations while pursuing certain initiatives especially in countries with distinct demographic trends (e.g., an aging society).

Because this doctoral research targets the subpopulation of youth as the study population (also see Section 4.3), a UNEP survey conducted in 2008—when this doctoral research was carried out—is reviewed. According to this online survey (n=1999), a total of 88% of young people, ranging in age from 12 to 18 years old, across five countries (Brazil, India, Russia, South Africa, and the US) thought world leaders should do

“whatever it takes” to tackle climate change (UNEP, 2008a). The study also found that an average of 85% of the respondents across all five sample countries was concerned about climate change. A majority (89%) believed that young people like them could make a difference on the issue. The youth from Brazil, India, South Africa, and the US (the averages were above 90%) were more enthusiastic about their personal contribution than those from Russia (77%).

### Summarized Review

In brief, the public’s awareness toward global climate change has increased in the past two decades. While most people believe in the authenticity of the issue, they have doubt about the scientific consensus and anthropogenic influences. In addition, even though the public has a negative impression about climate-change impacts, most people do not seem to overly worry about the problem because they do not perceive climate change as an immediate threat to them. That most people consider climate change to be less personally relevant and psychologically distant may influence their sense of urgency to take action and their choice of prioritized public policies.

Moreover, while most Americans think that their government should support the Kyoto Protocol and implement a variety of national policies to reduce its GHG emissions, they place the responsibility of reduction on the government and industries. The public in the US tends to oppose tax policies that target households and consumers. These results suggest that the general public not only has different risk perceptions from scientific experts, but they also have different expectations about responsibility to combat climate change. This body of research suggests that scientists and policy makers have an obligation to improve communication with the general public regarding climate change.

### **2.3.4 Public Scientific Understanding of Climate Change**

The discussion in Section 2.2 points out that a scientifically literate citizenry is an essential component in a democratic society for addressing environmental problems with high scientific and technological complexity. In addition, social psychologists consider knowledge/cognitive expression as one important indicator of a person's behavior (Ajzen & Fishbein, 1980). Hence, it is an important task for environmental sociologists to investigate the general public's level of scientific understanding of global climate change.

However, compared to the great body of survey studies that have been carried out on public perception, a far smaller number have sought to measure the public's comprehensive understanding of climate change. Unlike opinion polls on which respondents can directly express their views, investigating factual knowledge requires more intensive cooperation because it is time consuming and it may not be popular (people may resist taking a quiz). This factor helps to explain why the most commonly used indicator of scientific knowledge in existing surveys is a simpler indicator—the knowledge of causes of climate change.

Nisbet and Myers (2007) analyzed Gallup's polls over the past two decades and found that only a small fraction of the American public has confidently self-evaluated their knowledge level of global warming as "very well," ranging from 11% in 1992 to 22% in 2007. The majority of the respondents felt that they understood the issue "fairly well," ranging from 42% in 1992 to 54% in 2007. Due to the lack of studies focusing on a comprehensive investigation of scientific knowledge, this subsection reviews findings in the following aspects (i.e., limited understanding and misunderstanding of climate change).

### *A Limited Scientific Understanding*

Early studies showed that although people are increasingly aware of global climate change, they have a limited understanding of its particular causes, consequences, and solutions (e.g., Bostrom et al., 1994; Read et al., 1994; Stamm et al., 2000). For instance, Read et al. (1994) found that Americans had a limited conception of climate change. Although most respondents knew the basic scientific concept of the greenhouse effect—the atmosphere traps heat from the sun—many of them did not view the phenomenon as a normal process vital to humans' survival. Furthermore, the respondents showed a moderate understanding of the mechanism of albedo—increasing albedo would reduce temperature because of the effects of increasing cloud cover and atmospheric aerosols (e.g., suspended dust and volcanic eruption particles) (Read et al., 1994).

Brechin (2003) analyzed two surveys conducted in 1999 and 2001 by Environics International and found that misunderstanding of the cause of climate change was observed on a worldwide basis. While many respondents correctly indicated deforestation and air pollution as causes, few respondents identified correctly that fossil fuels were the primary anthropogenic contributor to global warming in the 1999 survey. Of 27 countries, Finland was the country with the highest percentage of correct responses: 17%.

However, other studies revealed different results. The General Social Survey in 1994 and 2000 showed that the majority of Americans (61% and 62%) could correctly identify the use of fossil fuels (i.e., coal, oil, and gas) as a contributor to the greenhouse effect (Nisbet & Myers, 2007). A survey conducted by Spellman et al. (2003) in 2000 aimed to assess the level of scientific knowledge of British higher education students on the issue of global warming. The result revealed that a significant percentage of the

respondents (78% on average) had a fairly good understanding of ten scientific statements related to global warming and the greenhouse effect. Over 90% of the respondents correctly identified key causes of global warming (i.e., CO<sub>2</sub>, fossil fuels, and deforestation) and the largest GHG emitter in the world at the time (i.e., the US).

Based on multinational surveys in 2003-2004, Reiner et al. (2006) compared public opinions of climate change and energy-policy preferences in the US, the UK, Sweden, and Japan. Over 70% of the respondents in all four countries correctly understood that cars and coal plants increase the level of CO<sub>2</sub> in the atmosphere and that wind turbines either have no impact or reduce CO<sub>2</sub> levels and planting trees can decrease CO<sub>2</sub> levels.

Reiner et al. (2006) also observed one inconsistency—the knowledge about nuclear plants. Approximately 30% of the respondents in Sweden and over 60% of the respondents in other three countries either had an incorrect understanding of nuclear plants (i.e. nuclear power increases CO<sub>2</sub> atmospheric concentrations) or did not know the answer. Another inconsistency was the knowledge about CCS. The majority of the respondents in Sweden (60%) and Japan (75%) correctly identified that CCS could moderate global warming, while a lower percentage of the respondents in the US (20%) and the UK (40%) had correct answers.

In contrast to the reasonably good level of knowledge about the causes, the public appears to have a relatively poorer understanding of the adverse impacts and solutions to climate change. Nisbet and Myers (2007) found in the surveys taken in 2002, 2004, and 2005 that less than half of Americans (42%, 48%, and 43%) answered correctly to questions pertaining to their government's political responses to the Kyoto Protocol (that

the Bush administration had withdrawn support for the accord). In addition, Spellman et al. (2003) found that the British higher education students performed with a lower correctness rate in two scientific statements: the effect of volcanic eruptions on the global climate (52%) and global warming impacts on crop and timber production in Europe (52%).

### *Scientific Misunderstanding*

In addition to its limited scientific knowledge of global climate change, the public has for a long time confused the issue with stratospheric ozone depletion. Early studies by Bostrom et al. (1994) and Read et al. (1994) found that respondents tended (at least at the time) to confound the ozone problem with the greenhouse effect and weather with climate. Moreover, the respondents tended to problematically propose general pollution control as the most effective form of mitigation for climate change. Nisbet and Myers (2007) also found that a majority of Americans (57% in 1994 and 54% in 2000) were confused about global warming and stratospheric ozone depletion—they thought the greenhouse effect is caused by a hole in the earth's atmosphere.

Similarly, Gowda et al. (1997) reported a number of misconceptions on the part of American high school students. In addition to the common confusions (i.e., ozone depletion and weather), the students not only confused climate change with multiple unrelated environmental disruptions, but also mistakenly overestimated the temperature change—higher than adults and IPCC scientists. These scholars analyzed several factors that may cause students' misunderstanding: 1) inadequate information exposure on climate change (especially through academic channels); 2) skewed media coverage (especially through television); 3) erroneous judgements about complex phenomena

because of heuristic education; 4) generalization of environmentalism. Nonetheless, because the students expressed a high level of trust in scientists and teachers, Gowda et al. (1997) suggest that it is both the opportunity and responsibility of these two actors to educate and communicate this complex problem and to enhance the public's scientific understanding.

Furthermore, Sterman and Sweeney (2007) conducted an experimental study targeting highly educated adults in the United States (i.e., graduate students at Massachusetts Institute of Technology, MIT) to investigate their scientific knowledge of the mass balance principle and the basic process of GHG stabilization—atmospheric GHG concentrations will stabilize only when emissions equal removal. These researchers found a widespread misconception inasmuch as respondents believed that if GHG emissions decreased, the atmospheric GHG concentrations and the mean global temperature would soon also decline.

Another prior work by Sterman and Sweeney (2002) showed that even highly educated adults had a poor understanding of the basic stock-flow structure concept (e.g., water will overflow from a bathtub when inflow exceeds outflow). The authors argue that the respondents tend to intuitively think that there is a direct correlation between the system inputs (e.g., emissions) and the system outputs (e.g., global mean temperature). This mistaken knowledge leads to the wait-and-see mentality and delayed policy responses because people think that climate change can be reversed quickly (Sterman & Sweeney, 2002; 2007).

### Knowledge vs. Behavioral Intentions

The last finding comes from a study that aimed to test the attitude theory—whether a knowledgeable person would be more likely to endorse climate-protection actions. Bord et al. (2000) conducted a survey of Americans in 1997 to assess public behavioral intentions to address global warming with three factors: knowledge about global warming, risk perceptions, and general environmental beliefs. The respondents (n=1,218) were asked to identify the primary cause of global warming among five actual (e.g., use of coal and oil) and four bogus causes (e.g., insecticides). The investigators also had respondents rate the likelihood of experiencing different risk-relevant events on an individual and societal basis and to answer a series of questions related to human-nature relationships in accordance with Dunlap's New Environmental Paradigm Scale.

The key dependent variable was respondents' behavioral intentions which were measured with two scales: the voluntary action scale and the policy referenda scale. The voluntary action scale consisted of five items of lifestyle choice (e.g., using more energy efficient household appliances and driving fewer automobile miles). The respondents were asked to rate their willingness to take such actions using a five-point Likert scale. The policy referenda scale was constructed from several hypothetical referenda questions (e.g., a \$1.00-per-gallon tax on gasoline and an energy-use tax on businesses). The respondents were requested to vote (support or oppose) on each policy.

The results of this study indicated that Americans were willing to support some, but not all, behavior changes and policies to address the global warming issue. While the majority of the respondents was willing to purchase an energy-efficient car (63%) and install more insulation in their homes (74%), few Americans would volunteer to drive

less (31%) or use less air conditioning and heat (42%). Additionally, a total of 69% of the respondents were willing to support a government program to preserve rain forests throughout the world, while 82% opposed a \$1.00-per-gallon tax on gasoline.

Although all three variables (i.e., knowledge about global warming, risk perceptions, and general environmental beliefs) were significantly correlated with behavioral intentions, the multivariate analysis showed that correct understanding of the causes of climate change was the strongest determinant of both stated intentions to take voluntary actions and to vote on hypothetical referenda to enact new government policies to reduce GHG emissions. The authors concluded that “a general pro-environmental stance is insufficient to ensure responsible decision making. Responsible decision making requires at least some minimal knowledge of cause and effect.”

Nevertheless, based on the ACE model discussed in Subsection 2.3.2, Krosnick et al. (2006) argue that enhancing knowledge would likely increase a person’s certainty, which would then increase his/her assessment of the seriousness of the issue, which in turn would increase policy support. In other words, knowledge itself may not necessarily increase people’s support for a relevant policy. To activate this cognitive pathway with these reasoning steps, knowledge has to be in place along with the beliefs about the existence of climate change and the attitudes about human responsibility. This mechanism is more complicated than what the deficit model posits—namely that greater knowledge about the issue leads directly to more positive attitudes toward it.

### Summarized Review

In summary, while numerous polls and surveys have investigated the public’s general concerns about climate change, far fewer studies have been specifically focused on

assessing the public's level of scientific knowledge of the problem. In addition, because most research has used "the knowledge of the causes of climate change" as an important indicator of overall knowledge, it has thus far not been possible to provide a complete analysis of the public understanding of climate change in terms of causes, consequences, and potential solutions.

Accordingly, it appears that although people have an increasing understanding of the anthropogenic causes of climate change (i.e., the role of fossil fuels in contributing to the problem), they show limited knowledge of the impacts of and possible interventions to address climate warming. Moreover, the confusion between climate change and ozone depletion has been observed now for two decades. Furthermore, Bord et al. (2000) argue that a correct understanding (especially the causes) of climate change is a significant variable for enhancing behavioral intentions to take climate-change protection. Scholarship advises both education and communication to enhance the public's basic scientific knowledge.

### **2.3.5 Public Participation in the Development of Climate Policy**

As discussed in Section 2.2, there has been an increasing need over more than a half century to engage the public in various public affairs under systems of democratic governance to effectively manage the challenges of scientific expertise. A controversial issue with a high level of scientific complexity like global climate change especially requires the participation of numerous societal actors. Kempton (1991) argued that it is necessary to involve citizens' perspectives in the formulation of climate policies because the effectiveness of GHG emission mitigation measures requires cooperation from consumers and workers. Moreover, adaptation strategies to limit adverse climate impacts

require compliance from a wide range of potential victims (e.g., farmers, residents in vulnerable areas to natural hazards). Thus, this subsection aims to discuss how the involvement of the public can assist the development of climate change policies by reviewing relevant empirical studies.

### *The Development of Integrated Assessment (IA)*

The increased need for including stakeholder knowledge and enhancing stakeholder interactions in the policy-making process has given rise to an emergent method—Integrated Assessment (IA)—that has been extensively employed in social scientific research in recent years (see, e.g., Kasemir et al., 2003). Since the 1990s, IA has attracted attention due to the perceived need to offer a synthesizing assessment across diverse fields of expertise to policy makers regarding complex issues with high scientific uncertainty (e.g., global climate change) (Weyant et al, 1996). Klopogge and Van der Sluijs (2006) define the IA method as “an interdisciplinary process of combining, interpreting and communicating knowledge from diverse scientific disciplines.” More specifically, this collective learning process links models of different scientific communities into a more comprehensive model (Norgaard & Baer, 2005) and seeks to produce more rational strategies to respond to problems like climate change (Eder, 1999).

One instructive example is the assessment reports published by the IPCC that incorporate research findings from various disciplines (e.g., climate science, marine science, and economics). The process of writing an IPCC assessment report is elaborate and time-consuming because hundreds of scientists are involved in drafting and reviewing articles, exchanging feedback, and negotiating and building a consensus (Norgaard & Baer, 2005). To effectively provide integrated expertise to policy makers,

these reports are even drafted with a summary specifically for communicating with this audience (i.e., Summary for Policymakers).

In contrast to the traditional IA that primarily approaches issues from the privileged expert-framed perspective, Darier et al. (1999b) emphasize lay knowledge and reframe IA toward a more public-centered perspective. Kloprogge and Van der Sluijs (2006) argue that it is necessary to include stakeholder perspectives to enhance the quality of the assessment, to obtain public support and legitimacy, and to attain democracy. Van de Kerkhof (2006) furthermore asserts that the involvement of societal actors can enhance policy making in many aspects: mobilizing the specific expertise of these actors, improving awareness and support for specific policy measures, enhancing the legitimacy of the decision taken, and building new networks and coalitions.

#### *The Development of Participatory Integrated Assessment (PIA)*

To bridge the gap between the science of global climate change and relevant lay perspectives, researchers have developed a method that relies on the participation of ordinary citizens in IA. The resulting method, Participatory Integrated Assessment (PIA), seeks to break down the boundary between “the science domain” and “the policy domain” by engaging non-scientist stakeholders (non-scientific knowledge) with experts (natural science knowledge) to increase social acceptability of the proposed policy options (Kloprogge & Van der Sluijs, 2006).

A variety of techniques have been developed and are currently in use in the field of PIA such as consensus conferences, citizens’ juries, focus groups, stakeholder dialogue sessions, and so forth (see Subsection 2.2.5 and Subsection 4.4.2). Each of these techniques entails a unique set of objectives and methods. For example, a consensus

conference anticipates building an agreement that meets the needs of all participating stakeholders for a specific policy. Even though the consensus-building approach has numerous advantages (e.g., reduce conflict, increase compliance, improve policy, prevent litigation, and establish relationships), it has many disadvantages (Van de Kerkhof, 2006).

Because every stakeholder has different interests and priorities, the discussion has a tendency to conclude with an agreement over general principles rather than concrete results. Hence, the resultant consensus tends to be an agreeable/compromised decision rather than a quality decision. In addition, the consensus is likely to be biased because of the selection of participants—notably the prevailing mainstream perspective may directly influence the outcome of the discussion (Van de Kerkhof, 2006).

As a result, Van de Kerkhof (2006) provides an alternative approach: deliberation orientation. While a consensus-building orientation is a process of negotiation, deliberation is characterized as a process of argumentation and communication in which participants exchange opinions and viewpoints, weigh and assess different arguments, and offer reflections. In other words, the deliberation approach aims to let participants understand others' different position and does not require a consensus.

### *The Development of Integrated Assessment Focus Groups*

In addition to different objectives (i.e., to obtain a consensus or to obtain a meaningful communication process), these participatory techniques may use different mechanisms (e.g., conferences and workshops). The most common technique used for the issue of climate change over the past two decades has been the focus group (e.g., Darier & Schüle, 1999; Darier et al., 1999a; Darier et al., 1999b; Kasemir et al., 2000a; Stoll-Kleemann et al., 2001; Puy et al., 2008). The feature of the small group in the focus-group method

makes it easier for participants to interact with each other and more efficient to achieve a group conclusion than a large group setting like a conference.

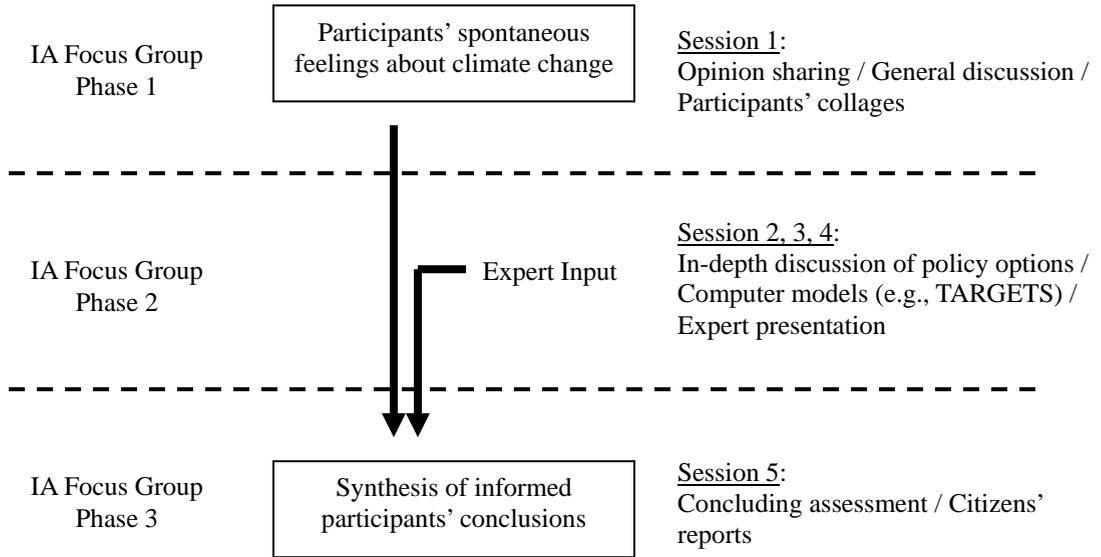
Most of these early undertakings were based on several major climate-related European projects during the late 1990s (e.g., ULYSSES, CLEAR).<sup>27</sup> These projects across Europe were considered as pioneering not only in engaging the general public in the assessment, but also in developing the IA focus-group method (Kasemir et al., 2000a). The ULYSSES project involving approximately 600 citizens in seven European metropolitan areas (i.e., Athens, Barcelona, Frankfurt, Manchester, Stockholm, Venice, and Zurich) aimed to collect lay perspectives about climate change and to provide policy-relevant information for decision makers (Kasemir et al., 2003).

In addition, the procedure of the IA focus-group method was refined in the ULYSSES project. Kasemir et al. (2003) designed the process with five 2.5-hour sessions in three phases: participants' initial expressions, in-depth discussion motivated by expert input, and synthesis assessment (Figure 2.4). Some of the techniques used in this exercise included "image collages" (i.e., participants picture the future of different reduction targets with images provided), computer models (i.e., participants receive expert information of global change with a computer tool, such as TARGETS<sup>28</sup>), and citizens' reports (i.e., participants produce a written document outlining the group's conclusions).

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<sup>27</sup> ULYSSES stands for "Urban Lifestyles, Sustainability, and Integrated Environmental Assessment." CLEAR stands for "Climate and Environment in Alpine Regions."

<sup>28</sup> TARGETS (Tool for Analysing Regional and Global Environmental and Health Targets for Sustainability) is a computer model that provides graphs of global climate trends.



**Figure 2.4** The three phases of IA focus-group processes (Kasimir et al., 2003).

By incorporating experts into the process of interaction, the purpose of IA focus groups is not only to listen and to gather information, but also to enable participants to make informed decisions and to have a more effective discussion. Due to its various advantages, the IA focus-group method was employed in this doctoral research (see Section 4.4 for the detailed methods).

While the focal issue discussed in these early European studies (e.g., Darier & Schüle, 1999; Darier et al., 1999a) was quite general (i.e., general discussion on the problem of global climate change and responding actions), the dialogues in some of the later investigations were more narrowly targeted. For example, Puy et al. (2008) conducted several IA focus groups that provided valuable insights and recommendations for the forest bioenergy system in Spain. Cohen et al. (2006) used stakeholder-dialogue sessions to discuss adaptation options of water management in Canada.

### Example Studies of Integrated Assessment Focus Groups

Since global climate change involves a variety of issues and policies (e.g., energy and water management), this discussion emphasizes how these participatory exercises facilitate the development of climate policies rather than the context of policies. The following review selects a number of studies that are more relevant to this doctoral research to explain the workings of this process in detail using the classification system developed by Darier et al. (1999a).

Darier et al. (1999a) categorize the objectives of participatory focus-group studies into two clusters: research orientated and policy making. The research-orientated studies (e.g., Kasemir et al., 2000a; Stoll-Kleemann et al., 2001) collect participants' general perceptions regarding climate change during focus-group discussions. The qualitative results derived from these discussions can serve as tools to understand citizens' level of climate-change knowledge. For example, decision makers can take useful policy-relevant information and recommendations provided by citizens when considering a high-compliance policy. The PIA studies in this cluster indirectly contribute to the climate policy-making process.

On the contrary, rather than simply gathering the participants' opinions, the policy-making studies (e.g., Shackley & Deanwood, 2003; Cohen et al., 2006) include pragmatic exercises that engage stakeholders in constructing and contributing to the formulation of climate assessments, scenarios, and decisions. In other words, these two approaches differ in the extent to which public participation contributes to policy frameworks: the policy-making studies focus on "actual participation and direct contribution to the process and the context of policies" (Darier et al., 1999a)

Take the research-orientated objective. Kasemir et al. (2000b) involved the public in climate and energy-decision processes and observed how ordinary people developed their preferences about public choice. The result of the focus-group studies in the ULYSSES and CLEAR projects showed that participants tended to adopt an ethical approach to framing their discussions of climate impacts. Their perspectives on political responses were based on an intuitive appreciation of deep-ecology and the precautionary principle—the climate impacts are so catastrophic that there is a need to act on climate change despite the inherent costs and scientific uncertainties (Kasemir et al., 2000a).

However, while many participants expressed a desire to reduce energy consumption, they rejected high energy prices as a strategy for achieving this objective. Their views on mitigation measures were closer to an economic-management perspective that sought to implement a cost-minimizing climate policy after weighing the costs of mitigation and adaptation options (Kasemir et al., 2000a). Because of the inconsistent viewpoints of these European participants, Kasemir et al. (2000a) suggest that it is necessary to frame both perspectives in advocating climate policies—an ethical discussion of climate impacts with a discussion of cost-effectiveness mitigation options.

Another useful example is provided by a psychological study conducted by Stoll-Kleemann et al. (2001) that was based on 14 Swiss IA focus groups carried out as part of the CLEAR projects. These researchers investigated the underlying social and psychological factors that drive people to take (or not take) personal climate-mitigation actions. They found that although the participants recognized the potential impacts of climate change and the need for low-carbon futures, they tended to justify their inactions.

There was apparently a gap between attitudes and behaviors because of external-internal contradictions from a psychological perspective (e.g., societal norm vs. individual responsibility). What a society expects from an individual may not match with his/her belief system. This internal inconsistency, or dissonance, triggers a number of socio-psychological denial mechanisms (Table 2.4). For instance, even though respondents were aware of the problem and knew how they “should” react, they still denied their responsibility (e.g., I am not the main cause of this problem) or expressed their feelings of powerlessness (e.g., I am only an infinitesimal being in the order of things) (Stoll-Kleemann et al., 2001).

Stoll-Kleemann et al. (2001) analyzed the dialogues of the focus groups and discovered four common interpretations of participants’ justifications for their barriers to action (i.e., unwillingness to give up customary lifestyles, belief that the costs are greater than the benefits, doubts of technological and regulatory solutions, and distrust with the government’s capacity) (Table 2.4). It is instructive to take the comfort interpretation as an example; a participant expressed his/her opinion on public transportation as “You have to rely on public means of transport and depend on their schedule. I think that’s the main problem: you have to give up quite a bit of your comfort.” As a result, these authors suggest that more attention needs to be given to activate people’s social and psychological motivations to commit to adopting personal mitigation measures (e.g., providing an incentive) in the process of implementing climate policies.

**Table 2.4** Socio-psychological Denial and Displacement Mechanisms

Nine Ways of Denial	Four Interpretations of Denial
<ul style="list-style-type: none"> <li>• <u>Metaphor of displaced commitment:</u> “I protection the environment in other ways”</li> <li>• <u>To condemn the accuser:</u> “You have no right to challenge me”</li> <li>• <u>Denial of responsibility:</u> “I am not the main cause of this problem”</li> <li>• <u>Rejection of blame:</u> “I have done nothing so wrong as to be destructive”</li> <li>• <u>Ignorance:</u> “I simply don’t know the consequences of my actions”</li> <li>• <u>Powerlessness:</u> “I am only an infinitesimal being in the order of things”</li> <li>• <u>Fabricated constraints:</u> “There are too many impediments”</li> <li>• <u>After the flood:</u> “What is the future doing for me?”</li> <li>• <u>Comfort:</u> “It is too difficult for me to change my behaviors”</li> </ul>	<ul style="list-style-type: none"> <li>• <u>The comfort interpretation:</u> An unwillingness to give up customary habits and favored lifestyles.</li> <li>• <u>The tragedy-of-the-commons interpretation:</u> The construction of attitude and behavior connections that regard any costs to the self as greater than the benefits to others</li> <li>• <u>The managerial-fix interpretation:</u> A lack of acceptance that climate problem can be resolved by recourse to technological and regulatory innovation</li> <li>• <u>The governance-distrust interpretation:</u> An underlying lack of faith in the capacity of government to deliver climate change mitigation</li> </ul>

Source: Stoll-Kleemann et al. (2001)

These two research-orientated studies demonstrate how the administration of IA focus groups not only can provide researchers with qualitative insights regarding citizens’ perceptions, but they can also assist policy makers in considering climate options that are more acceptable to the general public.

In contrast, most of the PIA studies with the “policy-making” objective have to date been linked to the development of scenarios with lay knowledge in the assessment-making process. For example, Shackley and Deanwood (2003) engaged stakeholders in the construction of socio-economic scenarios for regional climate-change impacts (e.g., vulnerability of the coastal zone, agriculture, and biodiversity) in two

English regions. To construct a comprehensive IA of climate change impacts in 2050, in addition to climate change scenarios (a natural science perspective), four socio-economic scenarios (a social science perspective) were considered in the assessment.

First, approximately 100 stakeholders from various sectors were involved in three regional stakeholder workshops in 1999. After an introduction by expert presenters (e.g., regional planning teams), the group produced a qualitative description of several socio-economic scenarios with different levels of economic, societal, and environmental activities in the future (e.g., global sustainability and regional enterprise). These scenarios were then presented to a national stakeholder workshop to discuss potential impacts. For instance, the stakeholders came up with the storyline of potential spatial change of biodiversity under the global sustainability scenario: extensive farmland areas would be re-created as habitats due to concerns of sustainability (Shackley & Deanwood, 2003).

Shackley and Deanwood (2003) argue that stakeholder participation can serve as a mediating device between intellectual debate and policy deliberation because multiple stakeholders with different perspectives and interests can be involved in the scenario-building process. In the case of this particular exercise, diverse policy actors were willing to compromise their preferred future options to some extent because they wanted to contribute to the project and to have influence on policy development.

Similarly, to build a comprehensive regional assessment of the climate-change impacts on water resources in the Okanagan Basin in Canada, Cohen et al. (2006) used stakeholder-dialogue sessions to complement traditional quantitative climate-change models (e.g., the basin hydrological scenario, agricultural water supply and demand scenarios). A variety of stakeholders (e.g., regional water managers and irrigators)

participated in a full-day workshop that provided valuable insights. For instance, although groundwater may represent a viable alternative water source, the participants expressed concerns about the lack of groundwater-extraction regulations. They also recognized the importance of a governance structure and support for a basin-wide coordinated water-management program such as irrigation scheduling.

### Summarized Review

Based on the studies reviewed above, it is possible to make several general summarizing comments with regard to public participation in climate policy making. First, compared to numerous participatory projects conducted in Europe, fewer PIA studies have been carried out in other geographic regions. Moreover, with respect to doctoral research reported in this dissertation it will be interesting to observe how the public-driven PIA approach might be implemented in an Asian context where it is common for privileged experts to play dominant roles in the policy-making process.

Second, most PIA exercises have been research-orientated studies—they have indirectly enhanced the development of climate policies by providing general policy-relevant perceptions of participants with respect to global climate change. Even though participants may discuss some policy options in these studies, it is difficult to evaluate exactly how their views influence climate policies. Moreover, although the introduction of expertise is expected to assist the participants, the effect of the expert treatment on the participants requires a special design to assess (i.e., pre- and post- tests).

Finally, although some cases have engaged stakeholders in the construction of the scenarios that have come out of the assessment process, few PIA studies directly involve stakeholders in contributing to “real climate policies.” Kloprogge and Van der Sluijs

(2006) attribute the problem to the relative novelty of the PIA method and its indefinite role in local, regional, and global policy processes.

### **2.3.6 Concluding Remarks**

To understand the human dimensions of global climate change, social psychologists have investigated people's attitudes, knowledge, behavioral intentions, and their relationships. It is anticipated that these findings can help to predict and interpret actual choices of actions or inactions. Based on the foregoing review of numerous studies, it can be concluded that public awareness toward global climate change has increased in the past two decades. While most people (at least in the advanced industrial countries that have been the focal point of this review) recognize the authenticity of the issue, they evince only a moderate level of concern because they have doubt about the human influences of climate change and the immediate personal impacts of increasing atmospheric GHG concentrations. In addition, most people support government implementation of various policies to reduce CO<sub>2</sub> emissions, but they tend to allocate the responsibility to the government and industries and ignore their own responsibility.

Although the public demonstrates an increasing level of concern about climate change and an improving level of understanding of its anthropogenic causes (i.e., use of fossil fuels), the general public still demonstrates limited knowledge of the impacts and potential solutions. Bord et al. (2000) argue that a correct understanding of the causes of climate change can be used to determine people's behavioral intentions to combat climate change. However, the common misconception between climate change and ozone depletion is still observed among the general public.

Numerous researchers have argued that it is essential to involve the public in ongoing policy-making processes. The common practice, PIA, suggests that informed participants can help to develop climate policies that people will be more willing to endorse. While most studies to date have focused on collecting participants' perspectives on specific climate-related issues, very few PIA studies have sought to directly involve stakeholders in contributing to "real climate policies" because of the novelty of the method and its indefinite role in local, regional, and global policy processes.

## 2.4 Summary

Global climate change is a profound challenge for policy makers to manage because it contains all seven characteristics of environmental problems (i.e., the public nature, transboundary features, complexity and uncertainty, irreversibility, temporal and spatial variability, administrative fragmentation, and regulatory intervention) (Carter, 2001) (see Subsection 2.2.2). Successful placement of the issue on the political agenda and effective formulation and implementation of climate policies require recognition of the problem and collective efforts from numerous societal actors (e.g., scientists, mass media, and the public).

A democratic approach that involves a variety of perspectives in a deliberative policy process is likely to prove favorable in solving complex environmental problems. While both scientists and the public play important roles in the policy-making process, there is also a cooperative relationship between them—how scientists facilitate citizens' understanding of science for these complex problems and how citizens contribute their lay knowledge to aid scientists. The key objective in enhancing the public's scientific

literacy is to ensure the quality of the deliberations and the effectiveness of the resulting policy decisions.

Public understanding of science is not only politically essential for policy makers, but it is also a significant area of social scientific inquiry. The level of an individual's scientific knowledge is important because environmental attitude researchers anticipate that it, along with beliefs, attitudes, and behavioral intentions, can help to predict personal choices of action or inaction. Bord et al. (2000) argue that people with a factual understanding of the causes of climate change would likely be more willing to take individual initiative to address climate change and to support climate policies that can mitigate GHG emissions.

The review of numerous studies on the public understanding of global climate change found that the general public still evinces limited knowledge about the impacts and potential solutions to the problem despite improved understanding of its anthropogenic causes (i.e., use of fossil fuels). Nonetheless, while most people believe in the authenticity of the issue, they do not demonstrate a high level of concern because they have doubt about the human influences and the immediate personal impact of increasing atmospheric GHG concentrations. In addition, while most people support government implementation of various policies to reduce GHG emissions, they resist policies that may be individually harmful (e.g., gas tax).

An increasing number of participatory practices have involved scientific experts and the public in the climate policy-making process. A controversial issue like global climate change that involves a variety of interest groups especially requires sound deliberative processes through which different actors can communicate and exchange

perspectives. However, most existing studies have focused on collecting citizens' perspectives on specific climate-related issues rather than anticipating their contributions to "real climate policies."

In summary, global climate change is an environmental problem with high complexity and uncertainty so it is particularly important for social scientists to regularly conduct studies on the public understanding of climate change and on the relationship between scientific experts and the public. Additionally, given the fact that most studies on public understanding of and public participation in science and climate change are carried out in Europe and North America, social scientists have a responsibility to explore cases in other geographic regions. Therefore, this doctoral research attempts to bridge the gap by presenting a case study of the public understanding of climate change in Taiwan.

## CHAPTER 3

### CASE STUDY CONTEXT

#### 3.1 Overview

While social scientists attempt to study human perception of and responses to climate change, the factors that influence the public understanding of climate-change science may originate from proximate societal factors. In addition, regardless of the level of international political cooperation to address the issue, most meaningful climate policies can only be formulated and implemented by domestic systems of governance.<sup>29</sup> Thus, it is significant for an interdisciplinary climate-related case study to situate its analysis in a comprehensive understanding of the subject country that is the target of inquiry.

To enhance appreciation of the chosen study area and to facilitate interpretation of the research results, this chapter provides a detailed introduction of the political context under investigation. Section 3.2 discusses why Taiwan was chosen as the study location. Section 3.3 examines key social values of the Taiwanese people through two perspectives: political-cultural and socio-psychological. Section 3.4 reviews the emergence of environmentalism in Taiwan with respect to the evolution of its environmental movement and the public's environmental concern. Section 3.5 describes the current status of climate-change policies in Taiwan and introduces two mitigation policies under active consideration. The last section summarizes this chapter.

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<sup>29</sup> Despite the lack of federal actions in the US, several states have actively taken actions to reduce their GHG emissions. For example, ten northeastern states (e.g., New Jersey and New York) developed the Regional Greenhouse Gas Initiative—a regional market-based cap-and-trade scheme. California further launched an initiative to regulate automobile CO<sub>2</sub> emissions (Selin & VanDeveer, 2007).

## 3.2 Study Area—Why Taiwan?

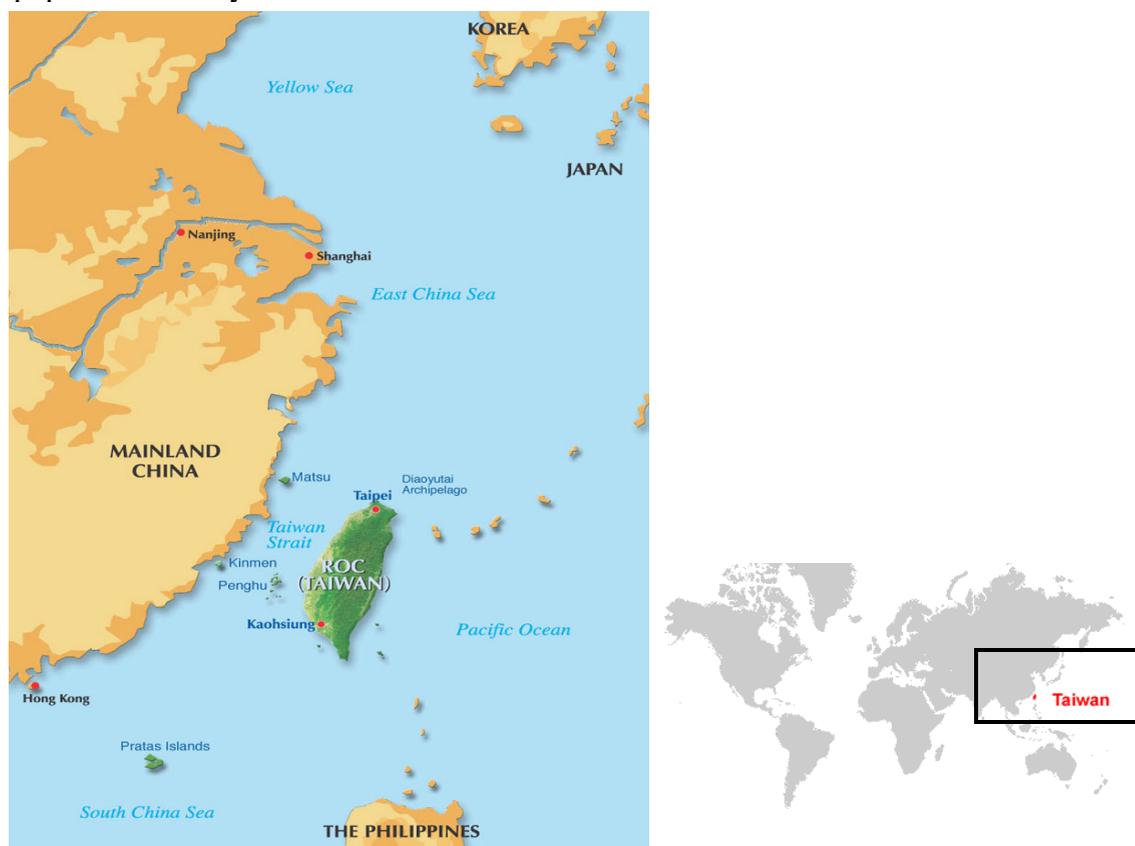
### 3.2.1 Introduction

Given the fact that several developing Asian countries—most notably China and India—are responsible for growing volumes of GHG emissions, securing commitments from these nations to mitigate releases will be important in managing global climate change over the long term. However, compared with numerous social scientific studies of global climate change in North America and Europe, substantially fewer investigations have focused on Asian countries. As attention for mitigation responsibility begins to shift to developing countries in the post-Kyoto period, it has become increasingly important to expand the scope of work to include geographic areas that have thus far been relatively neglected. For example, Yue and Sun (2003) argue that newly industrialized countries should be urged to bear partial obligations for mitigating emissions. Consistent with this challenge, the current research project seeks to increase contemporary understanding of the public-science nexus around the issue of climate change in Taiwan.

This section highlights a number of characteristics that make Taiwan a useful case study. Subsection 3.2.2 begins with a brief introduction of Taiwan in terms of its geography, sociopolitical system, and so forth. Subsection 3.2.3 analyzes Taiwan's responsibility for global climate change given its large per capita GHG emissions. Subsection 3.2.4 explains why this island is highly susceptible to a variety of adverse impacts of climate change. Subsection 3.2.5 describes how Taiwan's newly democratic system of governance can contribute to this doctoral research in terms of engaging the lay public in the policy-making process. Subsection 3.2.6 concludes with some summarizing remarks.

### 3.2.2 A Glance of Taiwan

Taiwan is an island located in Southeast Asia (southwest Pacific Ocean) comprising a land mass of approximately 36,000 square kilometers (13,900 square miles), an area roughly equal in size to the Netherlands or the combined area of the states of New Jersey and Connecticut (Figure 3.1) (GIO, 2009).<sup>30</sup> The island lies in a complex tectonic area with frequent seismic activity that gives rise to its mountainous topography. The highest point, the main peak of Jade Mountain, is 3,952 meters (12,966 feet) above sea level. Taiwan has a current population of 23 million people and ranks as the 14th most densely populated country in the world.



**Figure 3.1** The geographic location of Taiwan.

<sup>30</sup> The official name of Taiwan is The Republic of China (ROC) and comprises the main island of Taiwan, the Pescadores, Kinmen, Matsu, and a number of other islets. This dissertation uses Taiwan to refer to the assemblage of territory as a whole because this is the more familiar nomenclature used throughout the world.

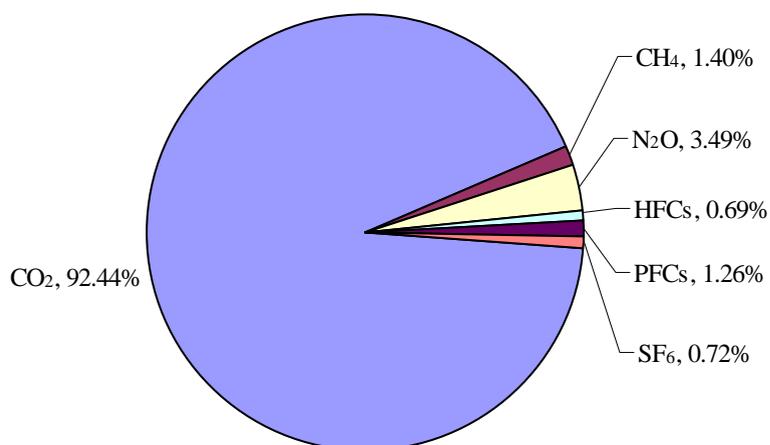
Taiwan has an oceanic and subtropical monsoon climate owing to its geographic location relative to the Tropic of Cancer and warm ocean currents arrive from the south. Summers are long and humid with an average temperature of approximately 28°C. By contrast, winters are short and mild with the average temperature ranging from 15 to 20°C. In addition, the average annual rainfall is nearly 2,500 mm. Three primary precipitation sources include monsoons in winter and summer, and thunderstorms and typhoons in summer. While these tropical cyclones cause severe damage due to strong winds and heavy rainfall, they also provide an important source of water (GIO, 2009).

Taiwan maintains a market-driven, capitalist economy with a strong orientation toward export production that made it the 24th largest economy in the world in 2007. It has a nominal gross domestic product (GDP) per capita of nearly US\$16,800, the 38th highest in the world. Its actual purchasing power parity (PPP) was equivalent to more than US\$30,000. In 2007, three major sectors contributed to Taiwan's GDP in various proportions: services (71.1%), industry (27.5%), and agriculture (1.5%). These fractions have changed significantly over the past two decades—the proportions in 1987 were services (50.3%), industry (44.4%), and agriculture (5.2%) (GIO, 2009).

Moreover, as a relatively young democratic system, Taiwan has experienced not only a dramatic political transition from an authoritarian to a democratic regime over the past two decades, but also a shift toward a more liberal and diverse civil society. The Taiwanese government has conducted four presidential elections since 1996 and experienced two successful political power transfers between parties (in the presidential elections in 2000 and 2008). The Taiwanese people now have more opportunities to participate in the political process and in social movements.

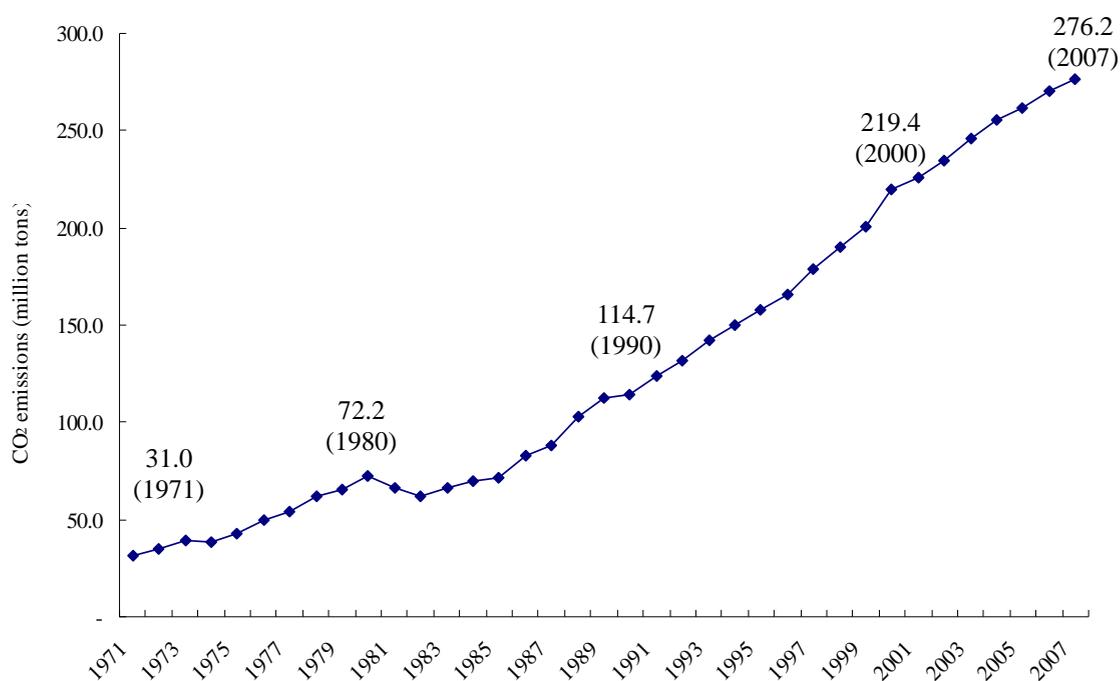
### 3.2.3 High Responsibility

Taiwan is an important contributor to global climate change because both its total CO<sub>2</sub> emissions and its releases per capita are ranked among the world's 30 largest emitting nations (IEA, 2009). Taiwan's total GHG production, excluding the impact of land-use change and forestry, has doubled from 1990 to 2007 (TEPA, 2009). According to the Taiwan Environmental Protection Administration (TEPA) (2009), Taiwan generated 316 million tons of CO<sub>2</sub>-equivalent emissions in 2007, an amount that was equal to approximately 1% of global total emissions (its population is equal to roughly 0.35% of the global total). Among six major heat-trapping gasses, CO<sub>2</sub> comprises the largest quantity gas emitted (92.4%) in Taiwan (Figure 3.2). Therefore, the following analysis primarily uses CO<sub>2</sub> emissions to discuss why Taiwan is responsible for contributing to global climate change from the perspectives of energy use and economic development.



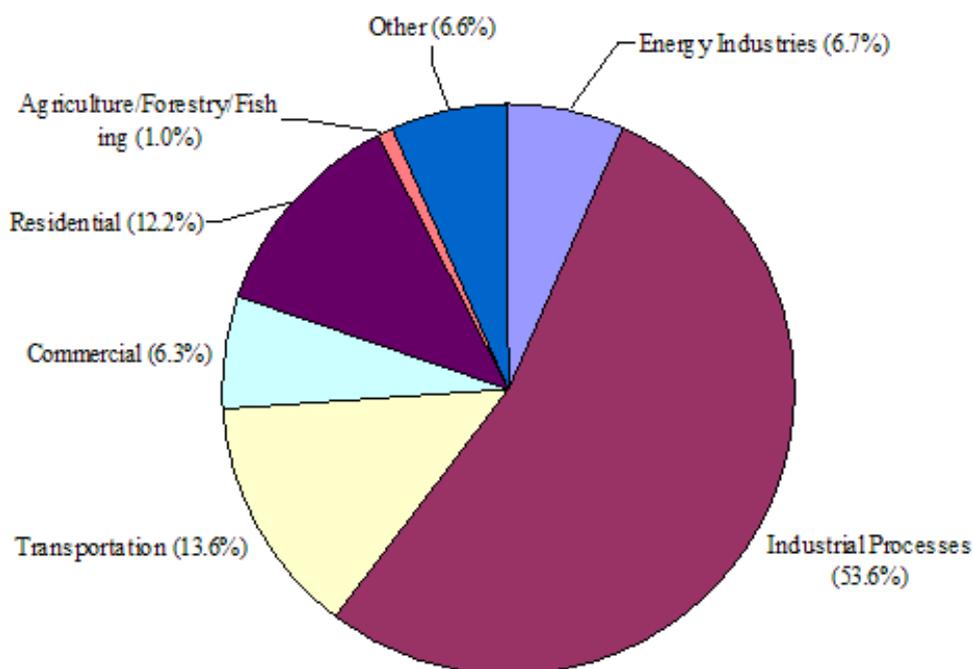
**Figure 3.2** The percentage of six major greenhouse gasses in the total GHG emissions of Taiwan in 2007 (316 Mt CO<sub>2</sub>-eq.) (TEPA, 2009).

Figure 3.3 illustrates that the CO<sub>2</sub> emissions from fuel combustion in Taiwan have increased by nine-fold since 1971 (IEA, 2009). Several studies have been conducted to investigate the reasons for Taiwan's rapid increase of CO<sub>2</sub> emissions (Chang & Lin, 1999; Lin et al., 2006; Lin et al., 2007; Chang et al., 2008). According to the Taiwan Bureau of Energy (2008), the total energy supply in Taiwan in 2008 was 142.5 million kiloliters of oil equivalent, 99.3% of which came from imported sources. In addition, fossil fuels (i.e., coal, petroleum, natural gas, and liquid natural gas) comprised 91.3 % of Taiwanese energy inputs. Nuclear power contributed an additional 8.3%, while renewable energy (e.g., hydroelectric, solar, and wind power) added less than 1% to the total energy supply (TBOEMEA, 2008). Moreover, approximately half of Taiwan's energy was consumed in the form of electricity (51.0%), followed by petroleum products (38.7%) and coal products (7.7%) (TBOEMEA, 2008).



**Figure 3.3** Carbon dioxide emissions from fuel combustion in Taiwan during the period 1971-2007 (IEA, 2009).

In 2006, 95.5% of Taiwan's total GHG emissions were the result of energy-related consumption and the remaining 4.5% was generated from industrial processes (TEPA, 2009). Because 77.0% of Taiwan's electricity is generated from fossil fuel-based thermal power plants, it is necessary to take electricity consumption into consideration when reviewing CO<sub>2</sub> emissions. After redistributing the amount of electricity consumed by each sector, the industrial sector accounted for 53.6%, the transport sector comprised 13.6%, and the residential sector consisted of 12.2% of Taiwan's total CO<sub>2</sub> emissions in 2007 (Figure 3.4) (TBOEMEA, 2009). In contrast, the CO<sub>2</sub> emissions in the US in 2007 were distributed by end-use sectors: the transport sector (33.8%); the industrial sector (27.6%); the residential sector (20.6%); and the commercial sector (17.9%) (USEIA, 2008). These data demonstrate two different carbon societies: production-orientated (Taiwan) and consumption-orientated (the US).



**Figure 3.4** Carbon dioxide emission distribution (including electricity consumption) by main sectors in Taiwan in 2007 (TBOEMEA, 2009).

The *2002 National Communication of Taiwan* stated that the activities that released the most CO<sub>2</sub> emissions include the iron and steel industry (30%), the chemical industry (28%), the textile industry (9%), and the electrical machinery industry (7%) (TEPA, 2002).<sup>31</sup> Various studies have demonstrated that expanding industrial production and electricity consumption are largely responsible for Taiwan's growing CO<sub>2</sub> emissions over the past two decades (Chang & Lin, 1999; Lin et al., 2007). For example, Lin et al. (2006) discovered that economic growth and high energy intensity were the key factors driving Taiwan's rising industrial CO<sub>2</sub> emissions between 1981 and 2001.

While the industrial sector generated more than half of Taiwan's CO<sub>2</sub> emissions, it contributed less than 30% of Taiwan's GDP in 2007 (TMEA, 2009). Lin et al. (2006) found that Taiwan's CO<sub>2</sub> intensity (unit GDP emissions) and CO<sub>2</sub> emission coefficient (unit energy emissions) were relatively high and grew rapidly during the period 1990-2000 compared to other countries (e.g., US, Japan). These data imply that Taiwan depends on relatively high energy intensive industries that are subsequently responsible for producing high CO<sub>2</sub> emissions (Lin et al., 2006; Chang et al., 2008).

Table 3.1 presents several indicators on energy, the economy, and the environment for Taiwan, the world, and the member countries of the Organization for Economic Cooperation and Development (OECD). While Taiwan (as noted above) accounted for 0.35% of the global population, its total CO<sub>2</sub> emissions, economic contribution, and energy consumption consisted of approximately 1% of global totals.

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<sup>31</sup> Signatory Parties of the UNFCCC were required to submit official national reports, known as national communications, by certain timeframes (i.e., 1995, 1998, 2003, and 2006). These documents highlight information including the GHG emissions inventory, climate-change policies and measures, vulnerability assessment, and so forth. Taiwan also follows the guideline to prepare its national communication.

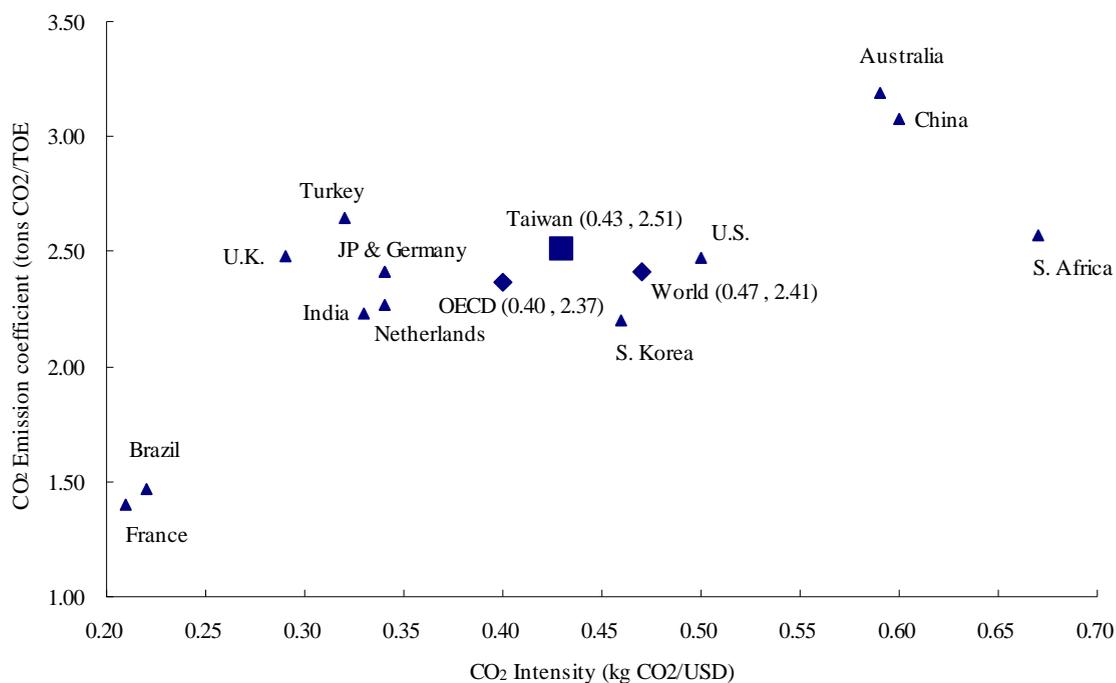
In addition, both its CO<sub>2</sub> intensity and CO<sub>2</sub> emission coefficients were higher than average for the OECD countries. This situation suggests that Taiwan emitted more CO<sub>2</sub> than the OECD countries for the same unit of energy consumed and the same unit of economic value created. Figure 3.5 further presents the comparison of these two indicators among selected countries. In brief, this situation arguably imposes a disproportionate obligation on Taiwan to take proactive measures to mitigate its GHG emissions.<sup>32</sup>

**Table 3.1** Taiwan's Energy/Economy/Environmental Indicators in 2007

	Taiwan	World	OECD	Taiwan in the World	
				Rank	%
Total emissions (million tons CO <sub>2</sub> )	276	28962	13001	22	0.95
Per capita emission (tons CO <sub>2</sub> /capita)	12.08	4.38	10.97	18	-
Population (million)	22.9	6609	1185	47	0.35
GDP PPP (billion USD)	636	61428	32361	18	1.04
Per capita GDP (thousand USD)	27.77	9.29	27.31	22	-
Energy supply (MTOE)	109.9	12030	5497	21	0.91
Per capita consumption (TOE)	4.80	1.82	4.64	22	-
CO <sub>2</sub> intensity: Unit GDP emission (kg CO <sub>2</sub> /USD)	0.43	0.47	0.40	53	-
CO <sub>2</sub> emission coefficient: Unit energy emission (tons CO <sub>2</sub> /TOE)	2.51	2.41	2.37	33	-

Source: International Energy Agency (2009).

<sup>32</sup> Given Taiwan's poor diplomatic status (i.e., it is not a member of the UN), the country is not a signatory party to either the UNFCCC or the Kyoto Protocol. Its participation in the diplomatic negotiation in the international treaties has been restricted. As one of the newly industrialized countries (e.g., South Korea), Taiwan may not be as responsible as industrialized countries (Annex I Parties), but it is expected to make more efforts than developing countries. However, its responsibility to reduce GHG emissions is not derived from diplomatic political obligations, but from an ethical perspective.



**Figure 3.5** Carbon dioxide emission coefficient and intensity among selected major countries in 2007 (IEA, 2009).

### 3.2.4 High Vulnerability<sup>33</sup>

Increasing evidence indicates that global climate change is affecting many areas of the Asian region. According to the Fourth Assessment Report of the IPCC, the area-averaged annual mean warming in East Asia (where Taiwan is located) is projected to be about 1.5°C in the decade of the 2020s, 3.6°C in the decade of the 2050s, and about 6.1°C in the decade of the 2080s under the scenario of high fossil-fuel consumption (IPCC, 2007b). In addition, the IPCC forecasts that the mean annual increase in precipitation is forecasted to be approximately 2.5% in the 2020s, 8.5% in the 2050s, and 15.3% in the 2080s. With

<sup>33</sup> Vulnerability is defined as “the degree to which a system is susceptible to and unable to cope with, adverse effects of climate change, including climate variability and extremes” (IPCC, 2007b).

enhanced variability in both temperature and precipitation, the Asian region is likely to be adversely affected in terms of agriculture and food security, hydrology and water resources, coastal and low-lying areas, natural ecosystems and biodiversity, and human health (IPCC, 2007b).

In addition to numerous research reports about harmful impacts of climate change on a global scale, an increasing number of climate studies has been conducted on a local scale over the past two decades. Because of its unique physical environment, a mountainous subtropical island in Southeast Asia, Taiwan is highly vulnerable to the potential impacts of global climate change (TEPA, 2002). For example, Hsu and Chen (2002) examined characteristics of climate-change patterns in Taiwan and the relationship with global climate change over the past 100 years. Their results indicated that Taiwan has experienced an island-wide warming trend of 1.0-1.4°C over this time span. Of concern is the apparent fact that the warming effect was even more significant than the rise in average global temperature during the same period.

Analysis also suggests that precipitation in Taiwan has increased in the northern region, but has decreased in the southern region over the past 100 years (Hsu & Chen, 2002; Yu et al., 2006). Although the higher rate of precipitation was not observed island-wide, most regions in Taiwan have exhibited a significant decrease in the annual number of rainy days. Moreover, the number of heavy precipitation days (daily precipitation exceeds 50 mm per day) has increased at remote stations in the areas of northern and eastern Taiwan. The observed trend in temperature and precipitation is consistent with changes in the global climate system (Hsu & Chen, 2002).

As highlighted in the IPCC's Fourth Assessment Report (IPCC, 2007b), the frequency and intensity of extreme climate events (i.e., heat waves, intense rains and floods, droughts, and cyclones/typhoons) have been increasing in Asia. It is instructive to take a recent natural disaster as an example. A strong typhoon, named Morakot, brought a tremendous amount of rainfall in August 2009. The Alishan weather station in the southern part of Taiwan estimated that accumulated precipitation was 2,965 mm in just four days (Taiwan Central Weather Bureau, 2009). This event caused severe floods, landslides, and mud flows, killing 634 people and causing approximately US\$500 million in damage.

Data from fourteen tidal stations during the past 90 years indicates that the sea-level has increased in parts of the north (0.035 cm per year) and south (0.061 cm per year) in Taiwan (TEPA, 2002). Furthermore, the excessive extraction of groundwater in southern coastal areas enhances the increased rate of land subsidence. Accordingly, the combined effect of sea-level rise and land subsidence is occurring at a rate of over 1.5 cm per year. While the coastline in the north has thus far remained stable, the coastline in the southeast has retreated by 20-50 meters over the past twenty years (TEPA, 2002). Additionally, it is estimated that if the sea level rises one meter in Taiwan, an area of about 272 km<sup>2</sup> (comprising 0.76% of the total national landmass) would be inundated (TEPA, 2002).

Chang (2002) used multiple regression models to investigate the impact of climate change on sixty different crops. The result showed that warmer temperatures and increased precipitation would decrease production of rice (Taiwan's most important staple crop) and several other agricultural products such as soybeans and sugarcane; the

novel conditions would positively affect certain vegetables and fruits. To sum up, two climate variables (temperature and precipitation) have a significant and non-monotonic impact on crop yields. Moreover, a temperature rise may not necessarily be singularly negative for farmers, but increasing rainfall intensity could be devastating to the welfare of rural communities in Taiwan (Chang, 2002).

In addition to the impact on agricultural productivity, climate variability is likely to directly and indirectly affect Taiwan's environment and society in a wide range of ways. For instance, dengue fever which usually occurs during summer and autumn in central and southern Taiwan is now spreading to the northern areas (TEPA, 2002). Moreover, most of the Taiwanese people live in the western flood plain due to the mountainous topography in the eastern part of the island. The dense pattern of settlement increases susceptibility to extreme weather events. However, it is necessary to embark upon more extensive investigations to establish the relationship between these local effects and global climate change with greater confidence.

In brief, given the fact that Taiwan is an island with relatively limited natural resources, high population density, and pronounced hazard vulnerability, the case of Taiwan (and in particular how the government develops domestic responses to the anticipated consequences of climate change) holds potentially instructive lessons for the rest of the Asian region. In addition, Taiwan's level of economic advancement and technology development should assist the government in formulating climate change adaptation policies (in contrast to most developing countries that lack the necessary capacity to cope with the adverse impacts of climate change). Such circumstances give Taiwan particular value as a case study with which to observe public responses to

climate-related risk and how these concerns may (or may not) influence people's intentions to endorse climate-management policies.

### **3.2.5 Sociopolitical Condition**

In addition to its economic organization and physical conditions, it is also instructive to consider Taiwan's sociopolitical conditions to appreciate the way that societal influences are shaping the formulation of domestic climate-change policies. Taiwan has a relatively young system of democratic governance that not only has experienced a dramatic two-decades long political transition after fifty years of authoritarian rule, but also has shifted in the direction of a more liberal and diverse civil society. After the abolition of martial law in 1987 and a series of open elections during the 1990s, the Taiwanese people now have more opportunities to participate in the political decision-making process and in social movement organizations.

According to the Taiwan Ministry of the Interior (2008), the average turnout rate in four presidential elections since 1996 was comparatively high (78.8%) and the average turnout rate in six national legislative elections since 1992 was 65.3%. In addition, civil society groups are able to participate proactively in the formulation of public policy. The number of national social associations, excluding political and industrial organizations, has increased from 486 in 1977 (the pre democratic era) to 8,542 in 2008 (TMOI, 2008). These data indicate that citizens in Taiwanese society are willing to become engaged with political and societal activities.

The process of democratization has stimulated the development of environmental politics in Taiwan (see the detailed discussion in Section 3.4). According to TEPA (2009b), the number of volunteers involved in environmental protection activities

increased from 101,606 people in 2003 to 150,914 people in 2008 (a growth rate of 48.5% over just five years). In addition, local environmental groups have actively launched climate-protection campaigns. For instance, a climate-awareness parade was organized in December 2007 and 2008 (Lin, 2008).

Moreover, since the political reforms in 2000, numerous citizen participatory practices have been conducted to promote deliberative democracy in Taiwan (Taiwan Thinktank, 2007). These practices not only provide opportunities for the general public to discuss a variety of national and local issues, but also assist academic expertise and governmental officials in improving the range of public participatory mechanisms and processes. For example; several citizen consensus conferences were organized to help identify public perspectives about the universal health care system and the adoption of surrogate motherhood legislation (Taiwan Thinktank, 2007). Additionally, the National Youth Commission, a secondary governmental agency, has organized a series of regional forums and national conferences to involve youth in deliberating various public issues.

In summary, Taiwan, as a newly democratic society, is currently experiencing the process of prosperous development of civil society and its involvement in the political system. Therefore, the sociopolitical condition in Taiwan provides a notable opportunity to conduct an empirical case study of participatory democracy around a highly complex environmental problem.

### **3.2.6 Concluding Remarks**

Taiwan was specifically selected as the study area for this doctoral research because it has several unique characteristics. First, Taiwan arguably bears a disproportionate responsibility for contributing to climate change because both its total CO<sub>2</sub> emissions and

its CO<sub>2</sub> emissions per capita are ranked among the world's top 30th largest emitting nations. The primary reason for this situation is that the Taiwanese economy depends heavily on industries with high energy intensities and high CO<sub>2</sub> intensities. Second, the island is highly susceptible to a variety of adverse impacts of climate change because of its physical environment, relatively limited natural resources, and high population density. Hsu and Chen (2002) found that observed trends in temperature and precipitation were consistent with changes in the global climate system and the local warming effect was even more significant than the increased average global temperature in the last century.

Finally, given its newly democratic system of governance, the Taiwanese people have opportunities to participate in political decision-making processes and in social movement organizations in ways not previously possible. Furthermore, a number of citizen participatory practices have been conducted to advocate deliberative democracy in Taiwan. Thus, the sociopolitical condition of Taiwan provides a notable opportunity to consider the development of participatory democracy around a highly complex environmental problem. In summary, this case study of Taiwan is advantageous because it demonstrates how a newly industrialized society is beginning to implement domestic climate policies via a participatory approach. In addition, the results of this research are potentially comparable with studies conducted in other countries that may share similar characteristics (e.g., high responsibility and high vulnerability).

### 3.3 The Changing Social Values in Taiwan

#### 3.3.1 Introduction

In addition to the detailed introduction of the study area in terms of its physiogeographic and economic characteristics, it is beneficial to develop familiarity with the people there—who these people are and what they think at a societal level of aggregation. Two key perspectives are employed: Alex Inkeles' (1997) national character theory<sup>34</sup> and Ronald Inglehart's (1997) intergenerational value change theory. This study deploys both theories to investigate four social values that are relevant to the current inquiry (i.e., public scientific understanding and public political participation): predisposition toward (anti)authoritarianism, sensibilities toward democracy/autocracy, sense of citizenship, and faith in scientists and experts (see Subsection 3.3.2).

This section highlights these distinguishing social values of the Taiwanese people through two standpoints: a political-cultural perspective and a socio-psychological perspective. Subsection 3.3.2 reviews the concepts of national character theory and intergenerational value change theory. Subsection 3.3.3 examines how the collective Taiwanese personality has been influenced by both traditional oriental culture and modern western culture throughout the country's dynamic history. Subsection 3.3.4 describes some key social values (e.g., viewpoints on citizenship and democracy) that are predominantly endorsed by Taiwanese people based on the result of a longitudinal survey: the Taiwan Social Change Survey (TSCS). Subsection 3.3.5 summarizes this section.

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<sup>34</sup> This national character concept does not mean that all members of the society have the same personality. Instead, it simply suggests that a majority of the given population will share some similarity of their values because they are enriched from the same social, cultural, political, and economic backgrounds. The study of national character can refer to a great range of meanings including emotions (e.g., reactions to shames), cultural traditions (e.g., values to family), and ways of acting (e.g., enterprising).

### 3.3.2 Enduring Characters or Shifting Values

While Alex Inkeles' (1997) national character theory and Ronald Inglehart's (1997) intergenerational value change theory both address a key social scientific question—what do people think of—they represent two oppositional perspectives on the notion of whether their values change over time. First, national character (also called modal personality) refers to enduring personality characteristics and patterns that are common or standardized among the adult members in a given society (Inkeles, 1997). For example, Putnam (1993) found that while Italy established new regional governments during the 1970s, these newly created democratic institutions led to dramatically different outcomes in the various regions. Despite massive historical economic, social, political, and demographic change, residents of southern Italy displayed the same low levels of civic involvement (e.g., electoral participation) that they had nearly a century earlier—and these tendencies had sharp influences on the effectiveness of institutional performance.

The contemporary study of national character can be traced back to attempts to develop psychological profiles to understand the behaviors of various combatants during World War II (e.g., Japanese tidiness, Russian tempestuousness) (Neiburg & Goldman, 1998; Cohen, 2000). The field was further developed by political scientists to study traits and attitudes toward democracy in different cultures (Almond & Verba, 1962; Putnam, 1993). Although Inkeles (1997) advanced the theory by implementing more rigorous statistical analysis rather than relying on subjective interpretations, the concept was overlooked and controversial because it required longitudinal empirical investigations.

The formation or the transformation of national character is deeply influenced by the dynamic socio-cultural system of a society, which means that while national

characters are durable, they are still changeable. It is thus significant for social scientists to understand the culturally patterned behaviors of the majority of citizens and the factors that shape these dispositions. For example, Inkeles (1997) found that while Americans had long had a tendency to be proud of their governmental institutions (e.g., Constitution, freedom, and democracy), this disposition of political confidence has been shaken since 1955.

In contrast, Inglehart's (1997) intergenerational (or postmaterialist) theory emphasizes a shift of values (i.e., values oriented around materialism in particular) in a society across generations. This concept, based on the notion of a need hierarchy (Maslow, 1954), states that once people have attained material security, they tend to prioritize their focus on more postmaterial values (e.g., self-expression and freedom).<sup>35</sup> This theory is, by extension, a core element of the postmodernization process—a transformation process from an economically driven traditional industrial society to an advanced industrial society that evaluates costs and benefits of economic achievement (e.g., environmental protection).

In particular, Inglehart contends that during the post-World War II era relatively younger generations (in comparison to their pre-war grandparents) who grew up in a context characterized by rapid industrial growth and economic development have switched their predominant concerns from economic and physical security (material values) toward self-expression and freedom (postmaterial values). He led a cross-cultural study of 43 societies that was carried out during the early 1990s under the auspices of the

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<sup>35</sup> Maslow's need hierarchy concept proposes that when people's physical needs (e.g., food, shelter) are attained, they tend to pursue physiological needs (e.g., esteem, self-expression, and aesthetic satisfaction).

World Values Survey to examine potential value shifts in a time span between 1970 and 1994. The results showed that almost all of the societies included in this research have experienced a statistically significant shift toward postmaterial values (Inglehart, 1997).

### **3.3.3 Political-cultural Perspective**

While both theories (i.e., national character and intergenerational value change) require longitudinal studies to observe whether people's values endure or shift over time, it is beneficial to examine historical economic, social, political, and demographic changes in a given society. Although there is no systematic psychological research specifically centered on Taiwanese characteristics, this discussion provides some observational insights from Taiwan's political and culture history. As shown in Table 3.2, Taiwan is a society that has experienced numerous changes in ruling regimes throughout its history. Each political transition not only brought changes in the socio-cultural system of the island, but also influenced its national character.

Reviewing Taiwan's political history, Tsai (2009) argues that both the eastern and the western cultures have influenced the development of some distinguishing characteristics of the Taiwanese people. On one hand, because most early inhabitants migrated from mainland China, the island has been deeply influenced by traditional Chinese culture (e.g., Confucianism).<sup>36</sup> Some of the traditional Chinese characteristics described by Hsu (1961) include lacking individualism, conservative (strongly favoring the status quo), highly competitive (restricted to family rather than individual goals), and submissive to authority (Inkeles, 1997).

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<sup>36</sup> Confucianism is an ancient Chinese system of moral, social, political, philosophical, and quasi-religious thought that has significantly shaped the culture and history of many East Asian countries for 2,500 years.

**Table 3.2** The Political Transformation History of Taiwan

Stage	Timeline	Key Development
Prehistory and early settlement	50000 BCE–1624 CE	<ul style="list-style-type: none"> <li>• Malay and Polynesian settlement.</li> <li>• Han Chinese began settling since 1200s.</li> </ul>
European rule	1624-1662	<ul style="list-style-type: none"> <li>• In 1544, a Portuguese ship named Taiwan “Ilha Formosa,” but it did not settle the island.</li> <li>• In 1624, the Dutch established a commercial base on Taiwan and made Taiwan a colony.</li> </ul>
Koxinga/ Imperial Chinese rule	1662-1895	<ul style="list-style-type: none"> <li>• Koxinga defeated the Dutch in 1662.</li> <li>• Qing Dynasty ruled Taiwan.</li> </ul>
Japanese rule	1895-1945	<ul style="list-style-type: none"> <li>• Taiwan was ceded to Japan by Qing China which was defeated in the war.</li> <li>• Japanese began the modernization and industrialization of the island by constructing railroads and developing commerce.</li> </ul>
Post-War Taiwan	1945-present	<ul style="list-style-type: none"> <li>• Kuomintang (KMT) martial law period: after being defeated by the Communists in the Chinese Civil War, Republic of China (ROC) retreated from mainland China to Taiwan.</li> <li>• White Terror period (1945-1987).</li> <li>• Modern democratic period: direct presidential election in 1990s began Taiwan’s democratization reform.</li> </ul>

Source: The Republic of China Yearbook 2008 (GIO, 2009)

These characteristics seem to be influenced by the predominant Confucian school of thought. Confucianism believes in humanity and is organized around two key tenets: 1) developing an internal benevolence and 2) maintaining harmony through external human relationships in a society (Yao, 2000). The first tenet suggests that people can be induced to behave properly through the operationalization of internalized rituals and the development of patterns of behavior based on ceremonial routines. The second tenet asserts that a harmonious society can be achieved if people subscribe to five relationships: father to son, elder brother to younger brother, husband to wife, elder to junior, and ruler to subject. These tenets shape people with qualities of citizenship and social responsibility.

In addition to these beliefs, Confucius and his edited book, *Analects of Confucius*, has influenced numerous students. Due to his significant role, teachers, scientists, and other purveyors of expert knowledge have enjoyed high respect in Taiwan. As a result, people who live in a Confucianism-influenced society tend to defer to the opinions of experts and respect elitism.

On the other hand, Taiwan has been extensively influenced by western culture. Due to its unique geographical location and rich agricultural resources, Taiwan has been regarded as an important commercial center in the Asian maritime trading network since the 17th century. Because of long contact with seafaring Europeans and Americans, Taiwan was one of the earliest Asian countries to experience the modern world of banking, business management, and international trade, as well as some western values that came with these institutions like the principles of law (e.g., procedural justice and the concept of impartiality), competition, individual interest, and democracy (Tsai, 2009).

These western dispositions stood in stark contrast to more authoritarian values associated with traditional Chinese society (Tsai, 2009). For instance, Chang et al. (2005) found that Confucian values have a negative correlation with democratic values, which means Confucian values and democratic values move in oppositional directions. Nonetheless, Tsai (2009) argues that Taiwan was able to integrate the traditional Chinese culture and the modern western culture and to develop its own characteristics.

As illustrated in Table 3.2, Taiwan has been invaded, colonized, and ruled by various external political regimes (e.g., The Netherlands, Japan, and ROC). To secure their authority, each of the newly arrived political regimes usually repressed Taiwanese people who vocalized antagonistic opinions. For example, thousands of Taiwanese elites

were killed or subjected to disappearance during the period of White Terror during the period from 1945 to 1987. Due to single party authoritarian rule, the populace did not have opportunities to participate in public affairs and tended to be fearful of expressing personal opinions in public.

Lin (2004) analyzed the Taiwanese society through a psychiatric perspective and discovered that people, due to Taiwan's long colonial history, have tended to display symptoms of the extensively documented Stockholm syndrome.<sup>37</sup> The relationship between island residents and the various ruling regimes evinces a contradictory psychology: fear but dependence. As a result, the long history of colonization of Taiwan drives the submissive personalities toward authoritarianism while at the same time being hesitate to outwardly express opinions.

After being ruled by several authoritarian political regimes over the last several centuries, Taiwan began to move in a more liberal direction after the elimination of martial law during the 1980s. This process gradually led to the implementation of more expansive democratic reforms and the first direct presidential election in 1996. The groundwork for this process of democratization was established to a large degree by the US during the decades after World War II.<sup>38</sup> During the process, the Taiwanese people began to understand their civil rights and to express their opinions in public.

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<sup>37</sup> The Stockholm syndrome is a psychological response sometimes seen in abducted hostages in which victims show signs of loyalty to their abductors, regardless of the danger (or at least risk) in which they have been placed.

<sup>38</sup> Taiwan was a close ally of the US in the fight against communism after World War II. The US helped to reconstruct Taiwan by providing nearly \$1.5 billion in financial aid during the 1950s and 1960s. The Congress further passed the Taiwan Relations Act in 1979 that reiterated American commitments to the security of the Taiwanese people. The United States urged the KMT government to undertake democratic reform after the emergence of increasing public pressure during the 1980s.

It can be concluded that the national characteristics of the Taiwanese people are influenced by two contrasting cultures: Confucianism and the ideals of western democracy. Chang et al. (2005) compared Confucian and democratic values in three Chinese societies: Hong Kong, mainland China, and Taiwan. Taiwan was the second in the level of modernization, the first in the level of democratization, and the last in Confucianism. They also argue that modernization is not only a strong contributor to democratic consciousness, but a factor causing shifts in Confucian values.

### **3.3.4 Socio-psychological Perspective**

As discussed in Subsection 3.3.2, it requires longitudinal statistical studies to determine whether people's values endure or shift over time. In addition, to assess Inglehart's (1997) intergenerational value change theory, one needs to measure if a majority of the population in a society shifts values over time and assess the extent of any purported value changes across different generations (i.e., whether the grandparents' generation had different values from the current generation).

Marsh (1999) suggests that there are significant differences in various social values across three generations of Taiwanese. The first generation comprises people born between 1894 and 1917 who lived their lives during the Japanese colonial period. The second generation encompasses people born between 1918 and 1941 that experienced World War II.<sup>39</sup> The third generation consists of those people who were born between 1942 and 1967 and benefitted greatly from the rapid economic growth and social modernization after World War II.

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<sup>39</sup> Because Taiwan was ruled by Japan during World War II, it was part of the war zone. Many Taiwanese men were enlisted in the Japanese army. In addition, the American air force attacked Taiwan and these bombing raids caused thousands of casualties.

Marsh's study included two questions to assess viewpoints about political participation among these three generations (Table 3.3). Although the level of support for democracy over elitism (i.e., disagreement with the statement) increased over the course of the generations, the trend was not overwhelming because 42% of the most recent generation of respondents still expressed elitist responses. Moreover, the most prominent viewpoint shifted from a commitment to authoritarianism to a regard for democracy. While 78% of the first generation respondents trusted political leaders, 90% of the third generation respondents showed support for mass citizen participation (Marsh, 1999).

**Table 3.3** Questions and Responses of Viewpoints about Political Participation

Elitism vs. democracy of opinion	Some people think one has to have at least a high school education to have his opinions respected by others in society.
Authoritarianism vs. Democracy	<p>If you want to make Taiwan a better place, there are two opinions.</p> <p>a. All citizens should take an interest in politics and speak their opinions freely.  <b>Agreement:</b> Generation 1 (13%); Generation 2 (36%); Generation 3 (90%)</p> <p>b. Entrust everything to political leaders.  <b>Agreement:</b> Generation 1 (78%); Generation 2 (53%); Generation 3 (6%)</p>

Source: Marsh (1999)

The Taiwan Social Change Survey (TSCS) is a longitudinal nation-wide study launched in 1984 to track social values on a variety of topics through annual face-to-face interviews. Table 3.4 highlights a number of questions related to the perception of the role of citizens and the government and the resultant data provide some insight into the evolution of public attitudes on political participation over the course of the past two decades. The Taiwanese people seem to evince somewhat contradictory dispositions toward democracy and these inclinations fluctuate over time.

The 2005 data serve as an example (Table 3.4). While a majority of respondents display pro-democracy attitudes for questions B (“I better not get involved in public affairs because they are difficult to deal with”) and C (“As long as we often provide opinions, people like us can still influence societal development”), similar percentages of respondents are negatively inclined toward democracy for question A (“A general citizen can still influence the government’s decision”) and D (“If everybody has different/inconsistent viewpoints, the society will be chaotic”) (IOSSinica, 2006).

**Table 3.4** The Frequency Distribution of Attitudes toward Political Participation (1984-2005) (n range from 1895 to 4199)

	1984	1990	1995	2000	2005
A. A general citizen can still influence the government’s decision.	(%)	(%)	(%)	(%)	(%)
Agree (pro-democracy)	<b>57.6</b>	<b>51.4</b>	<b>49.7</b>	<b>52.9</b>	35.7
Disagree	25.1	29.7	39.9	38.2	<b>57.8</b>
B. I better not get involved in public affairs because they are difficult to deal with.					
Agree	27.7	39.5	43.3	44.4	44.5
Disagree (pro-democracy)	<b>60.4</b>	<b>46.4</b>	<b>48.0</b>	<b>49.3</b>	<b>50.6</b>
C. As long as we often provide opinions, people like us can still influence societal development.					
Agree (pro-democracy)	<b>59.3</b>	<b>55.3</b>	<b>62.2</b>	<b>62.8</b>	<b>53.7</b>
Disagree	23.0	25.3	26.6	27.9	39.7
D. If everybody has different/inconsistent viewpoints, the society will be chaotic.					
Agree	<b>70.5</b>	<b>62.7</b>	<b>61.5</b>	<b>58.0</b>	<b>61.9</b>
Disagree (pro-democracy)	15.9	26.0	30.6	32.7	32.6

Source: IOSSinica (2006)

The 2005 survey shows that while 53.7% of the respondents assert that they can influence societal development, only 35.7% of them believe that a general citizen can influence governmental decisions. In addition, 61.9% of the respondents feel that society will be chaotic if everyone’s opinion is inconsistent (Table 3.4). These seemingly conflicting attitudes can be further explained from the 2008 TSCS data (Table 3.5). A

majority of respondents do not believe that their opinions would be taken into consideration by governmental officials in the process of decision making. Nonetheless, two-thirds of the respondents (66.6%) think that casting votes is an effective way to influence politics.

In summary, since the democratic transition in the 1990s, the Taiwanese people have shown an inconsistent attitude toward political participation and have kept a traditional value: pursuing a harmonious society. Although most people have a positive attitude toward democracy at some level, they do not believe their opinions would be valued by government officials. This attitude may be driven by the fact that Taiwan is still in the process of democratization and that citizens are exploring their roles.

**Table 3.5** The Frequency Distribution of Attitudes toward Political Participation in 2008 (n=1980)

	Agree	Neither Agree Nor Disagree	Disagree
a. A lay person like me, only casting one vote, can make an influence on politics.	<b>66.6%</b>	11.2%	20.7%
b. The governmental officials will be concerned about the viewpoint of a lay person like me.	17.2	18.4	<b>62.8</b>
c. When the governmental officials want to do something, they will take into consideration the opinions of a lay person.	26.7	17.8	<b>53.5</b>

Source: IOSSinica (2009)

### 3.3.5 Concluding Remarks

This section seeks, on the basis of prior research, to sketch out a profile of the Taiwanese people that will be helpful in facilitating interpretation of the research results in subsequent chapters of this dissertation. The examination is conducted through two aspects: a political cultural perspective and a social psychological perspective. Because of its dynamic political transitions, the national character of Taiwan has been shaped by two

contradictory value systems: the traditional oriental culture (Confucianism) and the modern western culture (Democratization). First, Confucianism has had an impact on Taiwanese value dispositions through respect for teachers, scientists, and other experts. Second, as a result of colonial and authoritarian regimes over centuries, the Taiwanese people tend to be submissive to authoritarianism and hesitate to express opinions.

Moreover, Marsh (1999) argues that three generations of Taiwanese have significantly different attitudes toward political participation. Members of relatively younger generations have a positive disposition toward democracy and mass citizen participation and this temperament stands in contrast to their grandparent's generation that continues to maintain resolve for authoritarianism. However, according to the results of the TSCS, despite the democratic transition that has taken place since the 1990s, the Taiwanese people display contradictory attitudes on political participation. Although most people believe in democracy at some level, they doubt the efficacy of the general citizen. In other words, despite its high level of industrialization and modernization, Taiwanese society can still be regarded as having transitioned only partway from authoritarianism to democratic ideals. The predominant values of the polity give credence to democracy as a relatively abstract concept, but there is a lack of faith in the efficacy of citizenship.

### **3.4 Environmental Politics in Taiwan**

#### **3.4.1 Introduction**

Environmental reform in most Asian countries has followed a path that resembles the experience of most Western countries, namely rapid industrialization and urbanization, followed by massive environmental deterioration, followed by the ongoing diffusion of

societal awareness of the costs of such activities. However, the uptake of a modern sense of environmental consciousness in Taiwan has taken a somewhat more complicated road because the country's authoritarian political system was dominant for more than fifty years. As such, the development of environmentalism has been closely tied with the political transition in Taiwan.

During the authoritarian period, administrative agencies played leading roles in drafting and enforcing environmental regulations. In addition, it was often difficult to regulate polluters because numerous heavy industries were owned and operated by either the government or the ruling party—the KMT. This system of top-down governance changed gradually with the establishment of governmental environmental protection agencies at national and local levels and with the rise of an environmental movement in the late 1980s.

This section provides a discussion of the historical development and the current state of environmental politics in Taiwan. Subsection 3.4.2 first describes the evolution of the environmental movement in Taiwan from a political perspective. Subsection 3.4.3 reviews the emergence of environmental awareness among the Taiwanese people. Subsection 3.4.4 specifically examines how the public has perceived the issue of global climate change. Subsection 3.4.5 concludes with some summary remarks.

### **3.4.2 Evolution of the Environmental Movement**

While Taiwanese citizens enjoyed benefits from their rapid industrialization and economic growth after World War II, the island began to suffer from various forms of environmental deterioration (Chan, 1993). However, it was not until the early 1980s that an increasing number of local residents, concerned with the potential health impacts of

polluting sources such as petrochemical factories and landfills, started to express their dissatisfaction by organizing sporadic protests (Tang & Tang, 1997). These environmental protest movements were mostly local, politically moderate, and small in scale because martial law was still in effect during this period.

Tang and Tang (1997) argue that these demonstrations contributed more to the creation of opportunities for residents to express their frustration and to seek monetary compensation from industrial owners than they did to improvements of environmental conditions in particular communities. In addition, many of these campaigns failed because of various structural factors (e.g., the lack of nationwide environmental organizations due to martial law, dispersed interest motivation on the part of local factions, and manipulation of major mass media by the KMT regime) (Tang & Tang, 1997). This mode of nascent activism tended to be reported as being motivated by the irrational behaviors of a group of unreasonable, anti-development, and compensation-oriented residents.

A turning point, the cancellation of a proposed DuPont petrochemical plant due to strong local opposition in 1986, demonstrated to the general public that determination and better organization were the key success factors for collective action in grassroots environmental movements (Reardon-Anderson, 1992).<sup>40</sup> The number of environmental conflicts increased after the abolition of martial law in 1987 because the new political situation reduced the marginal costs (i.e., the risk of being arrested) among participants of

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<sup>40</sup> Regardless of potential penal consequences under the martial law, local residents in Lukang organized and demonstrated both in their community and in the capital city, Taipei, to oppose DuPont's plan of building a petrochemical plant. The protests directly challenged the KMT government's authority because this project was supported by major ministries in the central government. In the end, DuPont voluntarily withdrew its construction project, which represented a victory to many environmentalists.

protests (Hsiao et al., 1995). At a national scale, membership-based environmental organizations emerged after 1987 and these groups have not only supported and facilitated local environmental protests, but they have attracted the public's attention to broader environmental issues, such as wildlife protection, forest conservation, and water-resource preservation.

Furthermore, the TEPA was upgraded to a ministerial-level organization under the Executive Yuan (the executive branch) in 1987. During the 1990s, a number of environmental statutes were drafted, one of which was the Environmental Impact Assessment Act. It not only requires an independent review committee to assess the environmental impacts of major development projects, but also involves the public in the process (i.e., mandatory public hearings). This review process created a platform for comprehensive debates among different stakeholders and interest groups. As a result of this legislation, environmentalism in Taiwan experienced a transition from local protest movements toward more deliberative policy-making processes through the growth of civil society and the reform of environmental institutions.

After a series of open elections in the 1990s, the Democratic Progressive Party (DPP), the long-time opposition party, came to power in some municipalities and had their voice represented in the Parliament. In 2000, the DPP won the presidential election and this landmark event ended fifty years of KMT administration. Environmentalists were optimistic because the DPP was regarded not only as a stalwart companion, but also as a relatively environmentally supportive political party.

This close relationship between the DPP and environmental groups changed after the DPP administration cancelled the ongoing construction of Taiwan's fourth nuclear

power plant in 2000 (Hsu, 2005).<sup>41</sup> Without a parliamentary majority and skillful statesmanship, the administration was forced to continue the construction in the end (Ho, 2005).<sup>42</sup> In addition, under the pressure of an unprecedented economic recession in 2001 and a lack of remarkable achievements, the DPP administration was forced to sacrifice many its promised environmental reforms (Ho, 2005). As a result, Taiwanese environmentalists were disappointed with the DPP administration (i.e., their old ally in democratic movement over the past two decades) and outraged by what they perceived to be a foregone outcome engineered by business interests.

During the past two decades, strong environmental positions have become a crucial element of a solid pro-democracy coalition involving environmental movement elites, the opposition political party, and other social movement leaders against the authoritarian government in Taiwan (Kim, 2000). The emergence of an environmental movement in Taiwan is closely bound up with the process of democratic consolidation. However, because environmental groups were not organized as an autonomous political force during the democratization process, environmental issues tended to be marginalized in the political process when competing with other political interests.

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<sup>41</sup> With technological assistance from the US, Taiwan had constructed three nuclear power plants with six reactors by the mid-1980s. The construction budget of the fourth nuclear power plant (FNPP) was approved by the KMT-dominant legislature in 1994 (Hsu, 2005). However, the antinuclear movement, one of the key issues advocated by environmental groups, has never stopped. Because opposition to the construction of the FNPP has always been a core value of the DPP, President Shui-bian Chen abruptly announced the cancellation of the FNPP after he resumed office in 2000.

<sup>42</sup> When DPP won the presidential election in 2000, the party did not have a majority of seats in the Legislative Yuan. The KMT-dominant Legislative Yuan was in favor of the construction of the FNPP so they filed an appeal that stated the termination decision violated the constitution. The Council of Grand Justices later declared that the termination decision of the FNPP was procedurally flawed which demanded that the Executive Yuan immediately resume the constructions (Ho, 2005).

While the environmental movement in Taiwan has primarily focused on local issues to date, there are signs that individual groups have begun to advocate on some global environmental issues such as global climate change. For instance, dozens of civil society groups collectively initiated the “Anti-warming parade” in 2007 and several climate change-related campaigns (e.g., turn off the lights campaigns) (Lin, 2008). Mol (2001) argues that the main factors driving the globalization of environmental reform throughout much of East and Southeast Asian are either global or national because the region lacks supranational organizations like the EU.

These factors include global environmental regimes (e.g., international treaties), strong national environmental NGOs that link to global activist networks, support given by international development assistance programs, and global green markets that push regional or national producers toward environmentally sound production (Mol, 2001). However, because Taiwan is excluded from international diplomatic negotiations, it is of particular interest to observe the factors that are responsible for mobilizing the globalization of environmentalism in Taiwan.

### **3.4.3 The Emergence of Environmental Concern**

While the Taiwanese public became increasingly aware of the level of environmental deterioration in large parts of the island during the period after the 1980s, a number of surveys have been conducted to understand the public’s environmental concerns (e.g., Hsiao et al., 1995; 2002; IOSSinica, 2002). For instance, three national surveys in 1983, 1986, and 1999 (n=1,146, 518, and 1,495) asked about the public’s perception of environmental problems in terms of seriousness and urgency (Hsiao et al., 1995, 2002).

This work reported that on a list of 18 social problems, environmental pollution was regarded as the sixth most serious in 1983, ranked in second place in 1986, and ranked in fifth place in 1999 (Hsiao et al., 1995, 2002). The top four most serious social problems in 1999 included juvenile delinquency, bribery in elections, public safety, and unemployment. In addition, nine of eleven environmental problems (e.g., air and water pollution, solid waste, resource depletion, and energy shortage) were perceived to be more serious in 1986 than they were three years earlier (Hsiao et al., 1995).

The 2001 TSCS focused on investigating public priorities on various social problems (one of which was environmental issues). The respondents (n=2,052) were asked how they felt about environmental quality at present compared to the situation five years earlier and how they expected conditions to change five years into the future (i.e., worse, no change, better, do not know) (Table 3.6) (IOSSinica, 2002). The results suggested that a majority of the Taiwanese public thought that overall environmental quality had worsened over the preceding five years except for the longstanding issue of solid waste treatment.<sup>43</sup>

Meanwhile, they were pessimistic about the future. One third of the respondents thought that overall environmental quality would deteriorate, except solid waste treatment and wildlife habitats. In addition, the 2001 TSCS found that 37.1% of the respondents thought ozone depletion was the most serious global environmental problem, followed by climate change with 21.7% (IOSSinica, 2002).

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<sup>43</sup> According to the 2008 Yearbook of Environmental Protection Statistics (TEPA, 2009b), the total solid waste in Taiwan in 1996 (five years prior to the 2001 TSCS) was 8.7 million tons (Mt), which significantly decreased to 7.3 Mt in 2001 and to 4.4 Mt in 2008. In addition, the recycling rate has been improved from 1.2% in 1998, to 7.5% in 2001, and to 32.8% in 2008. These data imply that Taiwan has made a substantial effort in improving solid waste problems over the past two decades.

**Table 3.6** Public Concern about Environmental Quality in the Past and Future

	Past (5 yrs)	Future Expectation (5 yrs)	
Air quality (including acid rain)	Worse (80.4%)	Worse (52.7%)	DK (24.7%)
Water quality (river, lake, reservoir)	Worse (68.8%)	Worse (43.4%)	DK (26.9%)
Solid waste treatment	Better (52.6%)	Better (41.3%)	DK (25.1%)
Soil/water conservation in slope land	Worse (65.7%)	Worse (33.9%)	DK (31.6%)
Wildlife, forest, and wetland	Worse (40.0%)	Better (26.9%)	DK (36.2%)
Land and groundwater	Worse (59.6%)	Worse (37.7%)	DK (35.3%)
Coastal area	Worse (57.8%)	Worse (36.3%)	DK (35.7%)
Industrial pollution	Worse (63.9%)	Worse (37.9%)	DK (28.7%)

Source: (IOSSinica, 2002)

Tu (2004) analyzed the attitudes of the Taiwanese public about the relationship between environmental protection and economic growth using TSCS data from 1991, 1994, and 2001.<sup>44</sup> When asked to prioritize between economic growth and environmental protection in a 2001 survey, 46% of the respondents (n=2,052) selected economic growth and 40.8% selected environmental protection. The percentage of respondents prioritizing environmental protection over economic growth shifted from 53.2% in 1991 to 67.2% in 1994, to 40.8% in 2001, which may suggest that the economic recession in 2001 affected public attitudes. He further found that education and increased awareness of pollution were two important factors for prioritizing environmental protection—people who are more educated and more concerned about pollution tend to support the importance of the environment.

<sup>44</sup> The question regarding the trade-off between economic growth and environmental protection is commonly used in environmental surveys in Taiwan as an indicator of pro-environment or pro-development attitudes. This implies that the general framing of these two issues are oppositional. It may be interesting to discover if there is a potential for attitudes that simultaneously embrace these two goals.

Hsiao et al. (2002) further investigated if there was a possible paradigm shift in terms of the relationship between the environment and development between 1983 and 1999 (Table 3.7). The results showed the apparent inconsistencies inherent in the Taiwanese value system. Although a high percentage of respondents tended to accept a new environmental value set (e.g., limit to growth), they still wanted the benefits of technology and continued growth. Nonetheless, the proportion of the public that endorsed a pro-development attitude (items 5, 8, and 9) decreased from 1983 to 1999.

**Table 3.7** Environmental Consciousness—the Relationship between Environment and Development Index (1983-1999)

Questions	1983 (n=1,146)	1986 (n=518)	1999 (n=1,495)
	Agree (%)	Agree (%)	Agree (%)
1. Human must live in harmony with nature in order to survive.	95.6	99.2	98.4
2. We are approaching the limit of the number of people the earth can support.	88.6	85.5	91.3
3. Serious and disruptive shortages of essential new materials are likely if things continue.	83.7	87.5	89.0
4. A polluted environment can't be restored to its original state.	78.7	89.1	86.7
5. Industrial societies provide a high level of well-being for most people who live in them.*	91.6	89.7	85.4
6. The more industrial development, the more destruction of the natural environment will take place.	81.5	79.4	81.7
7. A nuclear accident resulting in the contamination of the environment is increasingly likely.	70.3	85.4	80.9
8. Science and technology are our best hope for the future.*	93.6	89.9	80.6
9. The good effects of technology outweigh its bad effects.*	91.3	88.9	76.1
10. The storage of nuclear wastes is too dangerous.	48.5	76.6	73.0

Source: Hsiao et al. (2002)

\* Pro-development items

In addition to the perceived tradeoff between environmental protection and economic growth, Wei (2001) investigated the disposition of the Taiwanese public with respect to environmental justice using the *1999 Environmental Consciousness in Taiwan Survey*. The result showed that although nearly 96.9% of the respondents recognized that it was a basic right to have clean air and water, 44.9% of the respondents agreed that the living environment of a minority of the population can be sacrificed for the benefit of Taiwan as a whole.

The 2001 TSCS also investigated the Taiwanese public's attitudes toward environmental action. First, the respondents (n=2,052) were asked about their preferred protest actions against a polluting factory in the neighborhood. The majority of the respondents would take moderate actions, such as reporting an incident to environmental and safety agencies (75.0%) or signing a petition (72.8%). Relatively fewer people would take aggressive actions, such as protesting in front of the factory (29.4%) or blocking the factory (16.6%). On a somewhat different matter, 77.6% of the respondents were willing to pay a higher price for a green product (IOSSinica, 2002).

The last question on the 2001 TSCS survey focused on the frequency of certain personal behaviors. A total of 54% of the respondents recycled often and 79.1% never littered. While 42.5% of the respondents never carried their own shopping bags, 54.5% often reused plastic bags. While 78.9% of the respondents never carried their personal tableware when dining out, 59.1% never used disposal tableware at home and 52.7% never drank bottled water at home. These results imply that the majority of the Taiwanese public tends to exhibit basic and moderate environmentally friendly behaviors in their daily consumer and household practices (IOSSinica, 2002).

A more recent 2006 *Environmental Protection Knowledge Survey* also provided some interesting observations with respect to environmental concern in Taiwan (Table 3.8) (TEPA, 2006). A majority of the respondents (i.e., two sample groups—the public and college students) recognized the environmental impacts of overly pursuing economic growth and the urgent need to protect the environment. Interestingly, most of these respondents were willing to lower their living standards for the goal of environmental protection—a sign of willingness to take individual environmental responsibility.

**Table 3.8** The Frequency Distribution of Agreements with Pro-environmental Attitudes

Statements	General Public (n=1,628)	College Students (n=1,270)
Overly pursuing economic growth would cause environmental problems	83.1%	94.5%
Protecting our environment is of urgent need	98.6	96.5
I would rather lower my living standards for environmental protection	82.2	78.5

Source: 2006 *Environmental Protection Knowledge Survey* (TEPA, 2006)

#### 3.4.4 Public Perception of Climate Change in Taiwan

There has not been significant research specifically focused on the public understanding of global climate change in Taiwan, but reviewing a number of surveys on general environmental issues can provide some valuable insights. These surveys have been motivated by a desire to understand the public's general environmental concern since the 1990s. In these investigations, one key aspect of environmental awareness was knowledge of international environmental issues, and a commonly-used indicator was the correct recognition of the focus issue of the Kyoto Conference in 1997.

First, a national survey *Environmental Consciousness in Taiwan* was carried out by the Institute of Sociology, Academia Sinica in 1999 and involved interviews with

1,495 randomly-selected households. This instrument revealed that 81.4% of the respondents did not know the major issue of the Kyoto Conference and 13.8% correctly identified the focus issue. Moreover, a majority of the respondents (42%) selected ozone depletion as the most pressing global environmental issue and 16% selected climate change/global warming (Hsiao et al., 2002).

In addition, according to a *2005 Environmental Protection Knowledge Survey* (n=1,208), 33.7% of college students correctly identified global warming as the focus issue of the Kyoto Protocol, 33.0% did not know the answer, and 27.1% misperceived that ozone depletion was the focus issue. Nevertheless, 77.7% of college students correctly recognized CO<sub>2</sub> and methane as the primary GHG (TEPA, 2005). The same survey (n=1,270) was carried out in 2006, and the result showed an increasing percentage of college students (55.9%) with the correct understanding of the issue of the Kyoto Protocol. In addition, the percentage of respondents who did not know the answer decreased to 17.1% (from 33.0% in 2005) (TEPA, 2006).

The 2006 survey (n=1,628) also extended the question to the general public. In this instance, 36.5% of Taiwanese people had heard about the Kyoto Protocol while a majority (63.5%) had not heard about this treaty. Among those who had heard about the Protocol, 41.6% correctly perceived the focus issue, while 36.9% of respondents thought (incorrectly) that ozone depletion was the key issue. Compared with Hsiao et al.'s (2002) study, the percentage of the general public's correct identification of the focus issue of the Kyoto Protocol had improved from 13.8% to 41.6% (TEPA, 2006).

The *2006 Environmental Protection Knowledge Survey* posed two additional multiple-choice questions regarding knowledge of the consequences of increasing CO<sub>2</sub>

emissions and of ozone depletion (see the questions in Table 3.9). In this case, 78.2% of college students and 35.9% of the general public correctly identified that global warming (greenhouse effect) is attributable to increasing CO<sub>2</sub> emissions associated with industrial activities. A total of 54.5% of the public and 18.3% of college students misperceived that ozone depletion was the consequence of increasing CO<sub>2</sub> emissions (TEPA, 2006).

Furthermore, when asked about the consequences of ozone depletion, 69.5% of college students and 45.3% of the general public correctly selected the option of exposure to excess ultraviolet light. A sizeable percentage of the general public (40.1%) and college students (24.6%) incorrectly selected the option of increasing temperature/sea level rise as a consequence of ozone depletion (Table 3.9).

**Table 3.9** The Frequency Distribution of Two Climate-Related Knowledge Questions

<i>Question 1)</i> What is the environmental consequence of increasing carbon dioxide emissions due to industrialization?	College Students (n=1,270)	General Public (n=1,628)
Ozone Depletion	18.3%	54.5%
Dust Storm	2.5	3.3
Global Warming (Greenhouse Effect)	78.2	35.9
Forest Wildfire	0.5	1.6
Do not Know	0.6	4.7
Total (%)	100.1	100
<i>Question 2)</i> What is the consequence of ozone depletion?	College Students (n=1,270)	General Public (n=1,628)
Exposure of excess ultraviolet light	69.5%	45.3%
Increasing Temperature/Sea Level Rise	24.6	40.1
Increasing Typhoon	1.7	1.2
Atmosphere Depletion	2.7	8.1
Do not Know	1.6	5.3
Total (%)	100.1	100

Source: 2006 Environmental Protection Knowledge Survey (TEPA, 2006)

These results suggest that college students have a better understanding than the general public in Taiwan regarding the topic of global climate change. It can also be found that ozone depletion was commonly confused with global climate change/global warming by both college students and the general public. Interestingly, the percentage of the Taiwanese public (54.5%) that misunderstood these two issues in 2006 was similar to the percentage of Americans (54%) who were confused about them in 2000 (Nisbet & Myers, 2007). Even though the timeframe may not be directly comparable (i.e., American data were from 2000 and Taiwan data were from 2006), it can be inferred that the confusion between global climate change and stratospheric ozone depletion is quite universal.

In addition to data on general perceptions about global climate change collected from common environmental surveys, Hsu (2006) conducted a national survey study that interviewed Taiwanese as part of a randomly gathered sample of college students and investigated the interrelationships between their knowledge, attitudes, and behavioral intentions toward climate change. The result first revealed that 100% of the respondents (n=773) had heard about the greenhouse effect, 98.1% had heard about climate change, and 76.0% had heard about the Kyoto Protocol. This level of familiarity with these climate-related terms implies that Taiwanese college students have been exposed to preliminary climate-change information during the mid-2000s.

Hsu (2006) then used twenty yes-or-no items to assess college students' level of knowledge on the issue of climate change in three dimensions (i.e., causes, impacts, and solutions). The investigation revealed that respondents had a satisfactory level of overall climate-change knowledge with an average score of 70 out of 100 (14 out of 20 questions

answered correctly). Moreover, the respondents performed better on the dimension of climate-change impacts (scored on average 80% of questions correct) than in the dimension of causes (70%). By contrast, they had a relatively limited knowledge (50%) of potential mitigation solutions and the international treaty (i.e., Kyoto Protocol).<sup>45</sup>

In addition, respondents expressed pro-climate protection attitudes with an average score of 3.9 on a 5-point Likert scale (a higher score indicates a pro-climate attitude). However, they displayed lower behavioral intentions with an average score of 2.9 on a 5-point Likert scale (a higher score indicates a higher willingness to take pro-climate actions). We can interpret this result to mean that despite Taiwanese college students' pro-climate protection attitudes, they were not so active themselves in taking mitigative climate-change actions (Hsu, 2006).

Finally, Hsu (2006) analyzed the relationships among three variables—knowledge, attitudes, and behavioral intentions—with respect to global climate change. First, the variable of climate knowledge was positively correlated with a pro-climate attitude ( $r=0.30, p<0.001$ ). Second, the variable of a pro-climate attitude was positively correlated with the variable of behavioral intention toward protecting the climate ( $r=0.26, p<0.001$ ). Finally, climate-change knowledge was positively correlated with behavioral intentions toward protecting the climate ( $r=0.22, p<0.05$ ) (Hsu, 2006). It can be concluded that each of these three variables is positively related to the other two variables, but the small correlation coefficients suggest that the relationships are marginal.

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<sup>45</sup> The cause dimension consists of seven items (e.g., the use of fossil fuels enhances the greenhouse effect). The impacts dimension includes five items (e.g., the enhanced greenhouse effect will cause sea-level rise). The solution dimension includes eight items (e.g., energy conservation can moderate the greenhouse effect). Assuming it is a test, an average score of 70% is considered to be satisfactory.

### 3.4.5 Concluding Remarks

The development of environmental politics in Taiwan has proceeded down a path that is roughly similar to the process that has transpired in most Western countries—a largely grassroots movement emerged in response to rapid industrialization and urbanization and the resultant environmental deterioration that took place as a result of these activities. The difference is that the development of environmentalism in Taiwan has been closely tied with the country's political transition due to its long-time authoritarian political system. This circumstance contributes to an interesting political dynamic—Taiwanese environmental groups tend to work in an alliance involving a variety of social activists.

Numerous studies suggest that the Taiwanese public maintains that overall environmental quality has been degraded and is unlikely to improve within five years. Additionally, although a majority of people endorse a pro-environmental value, they still endorse the government's emphasis on economic growth. Despite the fact that general awareness about global climate change has increased, there still exists in the public mind considerable confusion between global climate change and stratospheric ozone depletion.

Moreover, Taiwanese college students have a better understanding than the general public on the topic of climate change and display what can be constructed as a satisfactory level of familiarity on the topic. However, compared to their understanding of impacts and causes, comprehension of mitigation interventions is poor. In addition, even though Taiwanese college students seem to hold pro-climate protection attitudes, they have not been to date particularly active in their uptake of pro-climate mitigation behaviors. Finally, Hsu (2006) found that each of these variables (i.e., knowledge, attitude, and behavioral intentions) was weakly positively related to one another.

### 3.5 Domestic Climate Policies in Taiwan

#### 3.5.1 Introduction

While the international political community has been negotiating comprehensive climate regimes to combat global climate change since 1990, it is essential to formulate and implement domestic climate policies (i.e., mitigation or adaptation strategies) for achieving meaningful results.<sup>46</sup> This doctoral research primarily focuses on the mitigation policy option—how to reduce human-induced GHG emissions. As introduced in Section 3.2.3, Taiwan is highly responsible for contributing to this global problem because of its disproportional responsibility (i.e., 0.35% of the global population produced 1% of global GHG emissions in 2007). Although Taiwan is not a signatory to the UNFCCC and the Kyoto Protocol (hence no obligation), the government first began the process of formulating domestic climate policies in the 1990s. It is particularly interesting to explore some factors that prompted Taiwan's political actions and the current status of these domestic political efforts.

This section describes the current status of climate-change policies in Taiwan. Subsection 3.5.2 highlights the overall landscape of the politics of global climate change in Taiwan. Subsection 3.5.3 reviews the development of climate-change policy in Taiwan. Subsection 3.5.4 introduces two domestic mitigation policies that are specifically in the jurisdiction of the TEPA—a mandatory regulation (i.e., Greenhouse Gas Reduction Bill) and a voluntary program (i.e., Energy Conservation and Carbon Reduction Program). Subsection 3.5.5 concludes with some summary remarks.

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<sup>46</sup> Mitigation refers to an anthropogenic intervention to reduce the sources or introduce any mechanism that removes greenhouse gases. Adaptation refers to adjustment in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits beneficial opportunities.

### 3.5.2 The Politics of Global Climate Change in Taiwan

After the 1992 Rio Summit, the Taiwanese government initiated a ministerial-level working group to organize a variety of political responses to climate change including diplomatic negotiation, scientific research, awareness education, and formulation of policy responses. In addition, during the 1990s the National Science Council of Taiwan began to promote localized global change research projects and launched several international research networks (e.g., World Climate Research Programme) (TEPA, 2002). Moreover, in an attempt to deliberate energy supply-security strategies and to shift toward a low-carbon society over the long term, the Taiwanese government organized the National Energy Conference in 1998 and 2005.

Given Taiwan's diplomatic isolation in the international community (i.e., it is not a member of UN, so it is excluded from most official international negotiations), it is surprising to find that the government has actively responded to the problem. Being isolated may seem favorable because it prevents Taiwan from being regulated in the international agreements. However, the real situation is not that simple. Therefore, it is interesting to explore what factors drove the government to proactively take political responses since 1992 and what barriers impede the effectiveness of Taiwan's mitigation initiatives.

#### *Driving Forces of Political Action in the 1990s*

Due to the rise of globalization, Taiwan began to become aware of the significance of participating in international political affairs in the 1990s. Even though Taiwan is excluded from most diplomatic negotiations, the government managed to attend a variety of international conferences (e.g., COPs of the UNFCCC) using the status of NGO

delegations. In this compromised approach, government officials were able to observe the meetings, obtain updated information, and even arrange bilateral meetings. However, several trade sanctions were imposed on Taiwan by the US and many European countries in 1994 because it violated the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) for smuggling rhino-horn products (Yue & Sun, 2003).

This experience made the government realize that Taiwan would have to comply with the obligations of international agreements (e.g., the Kyoto Protocol) even without signing them or without participating in the negotiation process (Yue & Sun, 2003). This pragmatic concern about potential economic impacts due to trade sanctions was the primary reason driving the government to actively develop a political response to mitigate its GHG emissions during the 1990s (e.g., initiating a ministerial-level working group and consensus-building energy conferences).

In addition to concern about the possibility of having trade sanctions imposed on it, Taiwan considers itself an active member of the global community with responsibility to protect the environment (TEPA, 2002). This moral-obligation rationale anticipates the acquisition of political leverage in the international political community. By showing Taiwan's commitment, and by actively fulfilling its obligations, the government hopes to be included in the diplomatic negotiations. Yue and Sun (2003) argue that Taiwan's mitigation practices can demonstrate a "showcase effect" for other newly-industrialized and developing countries. As a newly-industrialized society with relatively high technological and financial capability, Taiwan's compliance with the Kyoto Protocol (even it is not obligated) can show a positive example to other newly-industrialized countries that are likely to become regulated during the post-Kyoto period.

*Potential Barriers to Effective Political Action*

If the Taiwanese government has attempted to reduce its GHG emissions during the 1990s, why are there no meaningful results regarding GHG emission reduction after nearly two decades? The following discussion argues that two potential barriers have impeded effective political actions in Taiwan—the scientific knowledge gap and the political challenge.

The first factor that has contributed to a delay of political actions in Taiwan is the scientific barrier. Subsection 2.2.3 highlights the functions and the roles that science and scientists can play in the policy-making process (e.g., theory builders and applied policy analysts). Even though the National Science Council of Taiwan has encouraged localized climate-change research projects since the 1990s, sound scientific evidence does not come quickly and easily, especially for an issue like global climate change which refers to variability of global climate patterns over time. Longitudinal studies are required to observe whether there is a change in the climate system, to confirm that the observed changes are results of global climate change, and to construct prediction scenarios.

For example, typhoons strike Taiwan every summer; it would take years to prove that the increased frequency and intensity of typhoons are adverse impacts of climate change. In addition, to provide advice, such as insights regarding GHG emission trends, to policy makers, scientists and experts need time to construct emission scenarios, to build GHG inventories, to assess socio-economic scenarios, and so forth. Therefore, bridging the scientific knowledge gap may be the foremost step to overcome in taking actual political actions.

The other potential factor impeding effective political actions is the political barrier. First, since climate-mitigation strategies involve collective efforts from multiple disciplines and government ministries in the national government (e.g., environmental protection, energy, and economics), a key challenge requires addressing the integration of various GHG-related government agencies due to the fragmentation of domestic politics (Huang & Lee, 2009). For instance, an energy-tax policy in Taiwan may involve the Environmental Protection Administration (TEPA), the Ministry of Economic Affairs (MEA), and the Ministry of Finance. However, the different and sometimes conflicting interests among these government agencies make it difficult to collaborate.

Furthermore, given the fact that Taiwan is responsible for producing high CO<sub>2</sub> emissions because of its dependency on relatively high energy-intensive industries, adjustment of the industrial structure in Taiwan (energy intensive industries vs. energy efficient industries) seems an effective approach for lowering GHG emissions. However, the weak status of the TEPA in the Executive Yuan (a secondary cabinet) causes difficulty in fighting against a prioritized agency such as MEA.

Second, even though the DPP took over the presidential office from the KMT after the political transition in 2000, the DPP administration struggled in implementing some policies and formulating new policies because of a lack of a parliamentary majority. To fight against the DPP administration, the KMT-dominant Legislative Yuan has boycotted many bills (including the Greenhouse Gas Reduction Bill) during the eight-year ruling period of the DPP (see Section 3.4 and Subsection 3.5.4).

Finally, similar to the process of forming an international agreement, a major controversy persisted on whether Taiwan should establish a specific GHG reduction

target and timetable and whether such targets should be put in the context of the GHG Reduction Bill. If such fixed measures are established, what target and timetable should be set? This dilemma has been debated in many national meetings not only by various stakeholders (e.g., industries and NGOs), but by different governmental agencies (e.g., TEPA and MEA) (Lin, 2008).

Environmental groups rigorously advocated the standard of Annex I Parties in the Kyoto Protocol (i.e., lower Taiwan's CO<sub>2</sub> emissions to the 1990 level by 2012). The MEA proposed that each sector and agency voluntarily reduce its GHG emissions based on its own goal. The target proposed by the TEPA was a resolution of the 1998 National Energy Conference: lower Taiwan's CO<sub>2</sub> emissions to the 2000 level by 2020—which was approximately 10 tons of CO<sub>2</sub> emissions per capita (Lin, 2008).

Some opponents of setting specific targets and establishing a timetable of GHG emission reduction argue that there is no need for Taiwan to act that proactively. They position Taiwan like other developing countries—that it just needs to comply with the post-Kyoto regime instead of the standard for industrialized countries in the Kyoto Protocol. In the end, although the draft GHG Reduction Bill does not include a specific reduction target and timetable, as a compromise, it authorizes the TEPA to establish a reduction goal for the future cap-and-trade scheme (Huang & Lee, 2009).

In brief, due to the scientific complexity and political sensitivity of global climate change, the discussion above can provide some insights about the compelling challenge of formulating and implementing domestic climate policies. It takes time to gather sufficient scientific evidence (to confirm scientific validation, to develop a potential solution, and to advise policy makers). It also takes time to achieve a societal consensus

for acceptable political actions. The next section discusses the evolution of climate policy making in Taiwan by examining two primary policy discourses in detail.

### 3.5.3 The Evolution of Climate Policy Making

Lin (2008) uses John Dryzek's (2005) discourse analysis approach to review the development of climate-change policies in Taiwan from 1992 to 2008 in terms of rationality, core values, discourse content, and strategy (Table 3.10).<sup>47</sup> In addition, based on Maarten Hajer's (1995) discourse-coalition theory, Lin (2008) identifies two major discourse coalitions in the climate-policy process in Taiwan: the environmental pragmatist discourse coalition and the climate action discourse coalition.<sup>48</sup>

Four primary discourse periods are identified during a 17-year time span: scientific knowledge discourse period (1992-1997); energy safety discourse period (1998-2000); nuclear-free homeland discourse period (2000-2005); energy conservation and carbon reduction discourse period (2005-2008). In this sense, the development of climate policies in Taiwan has been similar to the process that has taken place at the level of international society in terms of constructing scientific knowledge to advocating the reduction of GHG emission. In addition, the transition of each discourse coalition through time was influenced by several national events (i.e., in 1998 and 2005 the National Energy Conference and in 2000 the fourth nuclear power plant controversy) and by some

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<sup>47</sup> Discourse analysis is a tool for postempiricist policy analysts to examine the way we define, interpret, and address environmental affairs. Each policy discourse can be analyzed from the following elements: basic entities constructed; assumptions about natural relationships; agents and motives; and key metaphors (Dryzek, 2005).

<sup>48</sup> Discourse coalitions refer to a coalition of actors sharing the same policy discourse that focuses on narrative storylines rather than empirical evidence. Different discourse coalitions may compete for a position that can drive institutional practices and advocacy argumentation process (Hajer, 1995).

international events (i.e., the release of “*An Inconvenient Truth*” and Nobel Prize in 2007) (Lin, 2008).

**Table 3.10** Policy Discourse Analysis in Different Periods from 1992 to 2008

Period	Key Facet	Environmental Pragmatist Discourse Coalition	Climate Action Discourse Coalition
I. Scientific Knowledge Discourse Period (1992-1997)	Motive & Rationality	Scientific Rationality & Economic Rationality	Ecological Rationality
	Core value	Pragmatism	Sustainable Development
	Discourse Content	<ul style="list-style-type: none"> <li>• Avoid economic impact and trading sanctions</li> <li>• Follow the world trend of environmental protection</li> <li>• Lessen GHG emissions</li> <li>• Increase energy use efficiency</li> <li>• Construct climate change study at local perspectives</li> </ul>	<ul style="list-style-type: none"> <li>• Oppose nuclear power and energy intense industry</li> <li>• Criticize development</li> <li>• Set up GHG reduction target and timetable</li> <li>• Promote renewable energy and energy saving</li> <li>• Carbon tax</li> </ul>
	Strategy	<ul style="list-style-type: none"> <li>• Use control and economic incentives</li> <li>• Promote renewable energy</li> <li>• Consider nuclear power</li> </ul>	<ul style="list-style-type: none"> <li>• GHG emissions control</li> <li>• Carbon tax and economic incentives</li> </ul>
	Motive & Rationality	Economic Rationality & Technological Rationality	Ecological Rationality
II. Energy Security Discourse Period (1998-2000)	Core value	No regret Strategy	Sustainable Development
	Discourse Content	<ul style="list-style-type: none"> <li>• Promote energy diversity</li> <li>• Set up GHG reduction target and timetable</li> <li>• Increase energy use efficiency</li> <li>• Ensure the role of nuclear power</li> </ul>	<ul style="list-style-type: none"> <li>• Oppose nuclear power and energy intense industry</li> <li>• Set up GHG reduction target and timetable</li> <li>• Promote renewable energy</li> <li>• Adjust the industry structure</li> </ul>
	Strategy	<ul style="list-style-type: none"> <li>• Use control and economic incentives</li> <li>• Promote renewable energy</li> <li>• Reduce the ratio of manufacture industry</li> </ul>	<ul style="list-style-type: none"> <li>• GHG emissions control</li> <li>• Carbon tax and economic incentives</li> <li>• Consider GHG emissions in the environmental impact assessment</li> </ul>
	Motive & Rationality	Economic Rationality & Technological Rationality	Ecological Rationality
	Core value	No regret Strategy	Sustainable Development

Source: Lin (2008)

**Table 3.11** Policy Discourse Analysis in Different Periods from 1992 to 2008 (Conti.)

Period	Discourse	Environmental Pragmatist Discourse Coalition	Climate Action Discourse Coalition
III. Nuclear-free Homeland Discourse Period (2000-2005)	Motive & Rationality	Economic Rationality	Ecological Rationality
	Core value	Nuclear-free Homeland	Sustainable Development / Environmental Justice
	Discourse Content	<ul style="list-style-type: none"> <li>• Stop constructing the fourth nuclear power plant</li> <li>• Promote energy diversity</li> <li>• Increase energy use efficiency</li> </ul>	<ul style="list-style-type: none"> <li>• Stop constructing the fourth nuclear power plant</li> <li>• Cancel inappropriate energy subsidy</li> </ul>
	Strategy	<ul style="list-style-type: none"> <li>• Stop constructing the fourth nuclear power plant</li> <li>• Adjust the industry structure</li> <li>• Voluntary GHG reduction</li> </ul>	<ul style="list-style-type: none"> <li>• Promote renewable energy and small-scale power plant</li> <li>• Electricity market liberalization</li> </ul>
IV. Energy Conservation and Carbon Reduction Discourse Period (2005-2008)	Motive & Rationality	Economic Rationality & Technological Rationality	Ecological Rationality
	Core value	Pragmatism	Sustainable Development / Environmental Justice
	Discourse Content	<ul style="list-style-type: none"> <li>• Save energy and reduce carbon</li> <li>• Clean development mechanism</li> <li>• Adaptation strategy</li> <li>• Low carbon society</li> </ul>	<ul style="list-style-type: none"> <li>• Oppose to use nuclear power as an option to reduce GHG emissions</li> <li>• Low carbon society</li> <li>• Adaptation strategy</li> <li>• The role of cities</li> <li>• National security</li> </ul>
	Strategy	<ul style="list-style-type: none"> <li>• GHG inventory</li> <li>• Citizen campaign to reduce carbon</li> <li>• GHG emission trading</li> <li>• Capacity building of reduction</li> </ul>	<ul style="list-style-type: none"> <li>• Set up GHG reduction target and timetable</li> <li>• Carbon tax</li> <li>• Develop renewable energy</li> </ul>

Source: Lin (2008)

These two coalitions (i.e., the environmental pragmatist discourse coalition and the climate action discourse coalition) share some similarities with respect to objectives, but they have employed different rationalities and strategies. On one hand, the environmental pragmatist discourse coalition, mainly advocated by government agencies and industrial groups, emphasizes technical and economic rationalities. It tends to favor conservative policies that are technologically and economically feasible and politically implementable (e.g., renewable energy and energy-efficiency technologies with minimum economic impacts to industries; pragmatic policies such as GHG inventories) (Lin, 2008).

On the other hand, the climate action discourse coalition, mostly advocated by environmental groups, emphasizes ecological rationality. It tends to advocate more aggressive policies that are rooted in an environmental protection ideology (e.g., the industrial structure adjustment; mandatory GHG regulations). Because the key actors in this discourse coalition are environmental groups, the climate action discourse coalition has also taken the route of the emergence of environmental movements in Taiwan: criticizing development and supporting an ideal form of ecological rationality (Lin, 2008).

These two coalitions have employed different approaches. For example, the climate action discourse coalition has supported a specific GHG reduction target and timetable while the environmental pragmatist discourse coalition does not think that setting a specific target and timetable is necessary. However, it is interesting to find that even though the environmental pragmatist discourse coalition has gradually constructed the current system of climate change policies in Taiwan, the climate action discourse coalition has successfully influenced some policies over the past two decades. For

instance, the climate action discourse coalition proposed to adjust the industrial structure in Taiwan in the late 1990s and the concept was accepted and supported by the environmental pragmatist discourse coalition in the 2000s (Lin, 2008).

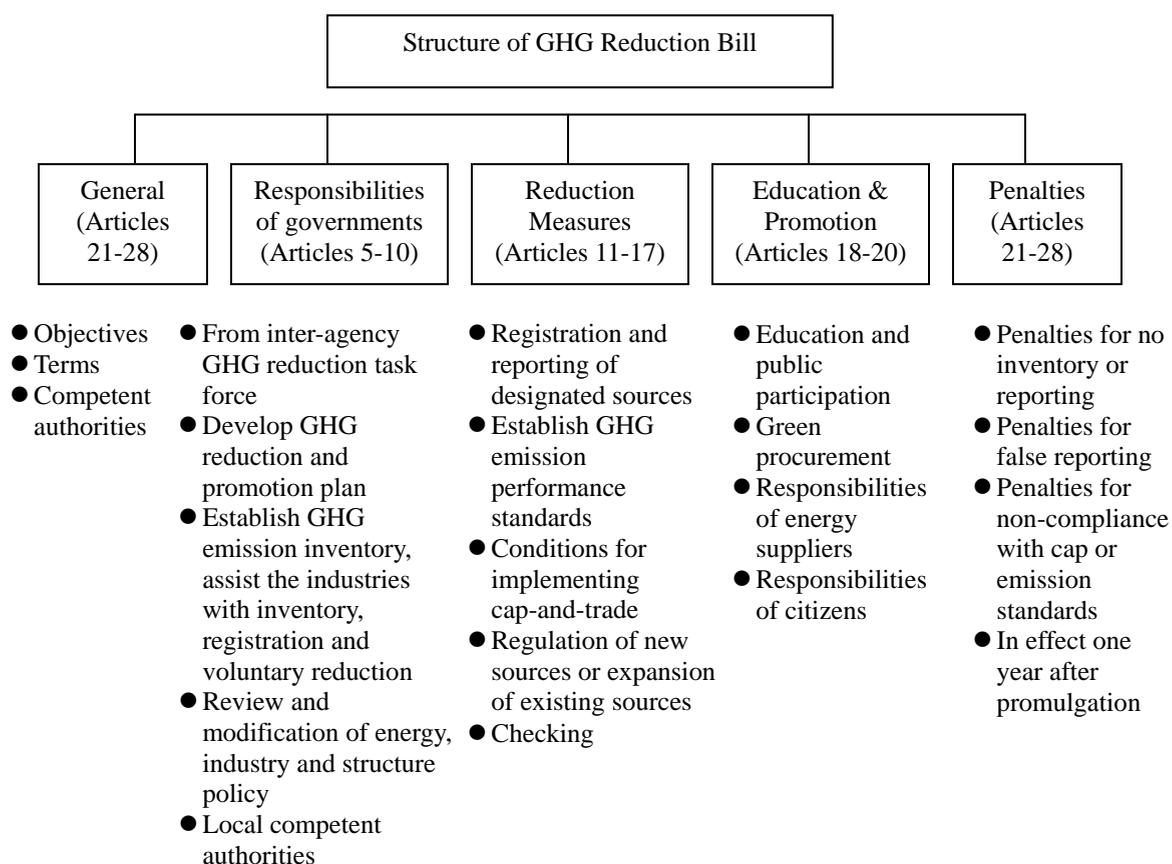
According to the *2002 National Communication of Taiwan* (TEPA, 2002), the government planned five major policy initiatives to stem the growth of GHG emissions: energy policy and energy structure adjustment; industrial policy and industry structure adjustment; agricultural developmental policy; forestry administration policy; and waste (wastewater) prevention policy. However, discursive constructions of climate change policies in Taiwan have centered largely on energy issues. Among numerous climate-related policies, this study specifically chooses two better-developed and ongoing mitigation strategies that are within the domain of the TEPA: the Greenhouse Gas Reduction Bill and the Energy Conservation and Carbon Reduction Program.

### **3.5.4 Two Domestic Mitigation Policies**

#### *Greenhouse Gas Reduction Bill*

As one of the GHG-related governmental agencies, the TEPA is directly responsible for formulating and implementing regulations for GHG emissions. To ensure a legal basis for controlling releases after the Kyoto Protocol entered into force in 2005, the agency began to prepare a cap-and-trade policy. The resulting mandatory statute, the Greenhouse Gas Reduction Bill, was drafted and submitted to the Legislative Yuan in 2006. At the time of this writing, the draft Bill was still under review. This draft bill contains 28 articles with four primary objectives: 1) mitigate global climate change; 2) reduce GHG emissions; 3) ensure national sustainable development; 4) fulfill responsibility to protect the global environment (Figure 3.6) (Huang & Lee, 2009).

As shown in Figure 3.6, the draft Bill first clarifies responsibilities among various government agencies (i.e., the central and local authorities). It then describes a three-stage progressive reduction process: 1) create an inventory system that regulated emitters can report and that the TEPA can monitor; 2) establish a GHG emission performance standard; 3) formulate an emission-trading scheme with reduction goals and emission allowances. Finally, the draft Bill clearly outlines the compliance regime and imposes penalties on fraudulent declaration, non-compliance with emission performance standards, and the cap-and-trade allowance (Huang & Lee, 2009).



**Figure 3.6** Structure of the draft GHG Reduction Bill (Huang & Lee, 2009).

In short, to build capacity to implement the bill after promulgation, the TEPA officially established a GHG Reduction Management Office in 2008 comprising three working groups: reduction planning, inventory and trading, promotion, education and adaptation strategies. The reduction planning working group is responsible for the legislation of the bill and potential international cooperation. The inventory and trading working group seeks to enable industries to build the GHG inventory and to comply with the cap-and-trade scheme. The education and adaptation working group aims to enhance public awareness of climate change by implementing CO<sub>2</sub> reduction campaigns (i.e., the energy conservation and carbon reduction program) and to draft related domestic adaptation strategies. Although the bill primarily involves industries—the major sector of CO<sub>2</sub> emissions—it is valuable to understand the views of the general public with respect to the apportionment of responsibility to various industries.

*Energy Conservation and Carbon Reduction Program*<sup>49</sup>

In addition to the mandatory GHG Reduction Bill that targets large GHG emitters, the TEPA launched a separate initiative called the Energy Conservation and Carbon Reduction Program (ECCRP) in 2008 that encourages people to voluntarily reduce their carbon footprints. First, the ECCRP Declaration consists of ten major actions and numerous daily life changing behaviors centered on transportation choices and consumption patterns involving energy, food and green products (Table 3.12). These recommendations aim to enable the general public to more easily understand what personal changes they can make to mitigate their personal CO<sub>2</sub> emissions.

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<sup>49</sup> The phrase Energy Conservation and Carbon Reduction (pronounced as “*Jie-Neng-Jian-Tan*”) has commonly been used in many climate-protection campaigns and media coverage. Carbon represents an abbreviation of carbon dioxide.

**Table 3.12** Energy Conservation and Carbon Reduction Declaration

Key Action	Daily Life Behavior
1. Use air conditioning more efficiently	<ul style="list-style-type: none"> <li>• Use air conditioning less and open windows more</li> <li>• Reduce wearing formal dress (i.e., suits and ties) unless necessary</li> <li>• Maintain air conditioning at 26-28 degrees Celsius</li> </ul>
2. Turn off appliances when not using	<ul style="list-style-type: none"> <li>• Turn off lights and unplug appliances</li> <li>• Review lighting needs and reduce unnecessary light bulbs</li> </ul>
3. Use energy saving lamps and save money	<ul style="list-style-type: none"> <li>• Change regular incandescent light bulbs to compact fluorescent light bulbs</li> </ul>
4. Consume green products	<ul style="list-style-type: none"> <li>• Purchase products with green labels, energy-saving labels, water-saving labels, and high energy efficiency ratio (EER) value.</li> </ul>
5. Ride a bicycle and walk more	<ul style="list-style-type: none"> <li>• Use stairs more; elevator less</li> <li>• Ride a bicycle to commute</li> <li>• Walk more to enhance health</li> </ul>
6. Reduce using private transportation tools	<ul style="list-style-type: none"> <li>• Use public transportation more</li> <li>• Reduce the frequency of driving (e.g., cars or motorcycles) along</li> <li>• Do not drive one day a week</li> </ul>
7. Select and use vehicles Properly	<ul style="list-style-type: none"> <li>• Purchase a hybrid or an electronic car</li> <li>• Turn off the engine when idling</li> </ul>
8. Consume food products with low carbon footprint	<ul style="list-style-type: none"> <li>• Choose local food products</li> <li>• Eat vegetables one day a week or one meal a day</li> </ul>
9. Reduce wasting resources	<ul style="list-style-type: none"> <li>• Carry personal tableware (e.g., chopsticks, cups) and shopping bags</li> <li>• Drink bottled water less</li> <li>• Reduce using disposal products</li> </ul>
10. Cherish resources	<ul style="list-style-type: none"> <li>• Use papers double sides</li> <li>• Use recycled papers</li> <li>• Reduce buying and using over-package products</li> <li>• Recycle materials</li> </ul>

Source: TEPA (2008)

Additionally, the ECCRP initiated a national campaign during the summer of 2008 that invited political leaders, government agencies, and public organizations to make a voluntary commitment to the declaration. This promotional effort included the establishment of an official website, the promotion of tours on campuses, and so forth.

Through a series of well-publicized activities, the TEPA expected to increase public awareness of climate change and to achieve some level of reduction from the public.

One key problem with this voluntary project stems from the obvious difficulty of identifying conscientious participants and assessing programmatic effectiveness. It is of particular interest to observe whether these commitment-signing campaigns are effective or just symbolic. In addition, the initiative places the emphasis and the responsibility of GHG reduction squarely on the public and consumers. It is thus worthy to understand how the general public—who are not the major CO<sub>2</sub> emission contributors in Taiwan—regard such a program.

### **3.5.5 Concluding Remarks**

Among numerous climate-change policies, this doctoral research focuses on the aspect of GHG emission mitigation. This section first describes the overall landscape of the politics of global climate change in Taiwan including the factors that drove the government to take actions in the 1990s and the factors that are potentially impeding the policy making in the 2000s. In addition, the development of climate policies in Taiwan is discussed. Lin (2008) identifies two major discourse coalitions in the climate-policy process: the environmental pragmatist discourse coalition and the climate action discourse coalition. The first coalition, emphasizing technical and economic rationalities, has thus far been responsible for constructing the system of climate-change policies in Taiwan. The later one, based on ecological rationalities, has been advocated by Taiwanese environmental groups.

Two different mitigation policies under the jurisdiction of the TEPA are described. The first one, a cap-and-trade statute (i.e., Greenhouse Gas Reduction Bill), has been

written and is at the time of this writing in the midst of moving through the legislative process. The draft Bill covers government responsibilities, reduction measures (i.e., emission-performance standards and the emission-trading scheme), and creation of a compliance regime. In contrast, a voluntary initiative—the Energy Conservation and Carbon Reduction Program—was launched to increase public awareness about reducing individual carbon footprints.

In addition to the different approaches being considered (one is potentially mandatory and another one is voluntary), these two policies target different groups to reduce their carbon footprints. The Greenhouse Gas Reduction Bill focuses on regulating industries and the Energy Conservation and Carbon Reduction Program emphasizes the role of the public, in particular the role of people acting in their capacity as consumers. Therefore, it is of particular interest to understand how the general public understands these two programs. This is why these initiatives were selected for special consideration in the empirical analysis discussed in Chapter 4.

### **3.6 Summary**

The influences that shape the public understanding of climate-change science may originate from locally orientated societal factors. At the same time, meaningful GHG mitigation policies can require endorsement by national governments. Under such circumstances, there is value in considering an interdisciplinary case study of how local views relate to policy activities. To enhance appreciation of the empirical analysis and to facilitate interpretation of the research results, this chapter provides a contextual introduction of the study area.

Taiwan is the target for this investigation because it is a relatively large contributor of international GHG emissions (ranked among the world's top 30 largest emitting nations). In addition, the island displays various vulnerabilities to the adverse impacts of global climate change. Taiwan's recent transition to democratic governance and its status as a newly industrialized society that is beginning to implement domestic climate policies via a participatory approach are other features that add to the potential value of this case study.

Moreover, the process of democratic reform that Taiwan has undergone is closely bound up with the emergence of environmentalism during the period since the early 1980s. The public became aware of the importance of environmental protection and lay understanding of global climate change has also increased. Although Taiwan is not obligated to ratify the UNFCCC and the Kyoto Protocol, the government started to address the issue to fulfill its nominal responsibilities. Two of the mitigation policies—the Greenhouse Gas Reduction Bill and the Energy Conservation and Carbon Reduction Program—will be subjected to more careful consideration in subsequent chapters of this dissertation.

## **CHAPTER 4**

### **RESEARCH METHODS**

#### **4.1 Overview**

Due to the complexity of global climate change, it is unlikely that human society will be able to resolve the problem from the perspective of a single intellectual or disciplinary domain. Interdisciplinary coordination and collective sustainable actions from all levels of society will be key to eventual success. Kasemir et al. (2003), for instance, argue that an integration of the social sciences with the natural sciences on climate change is necessary to support climate policy making in the future. Therefore, this research focuses on identifying the societal dimensions surrounding the effective construction of climate policies at the national level. To evaluate the integration of science and the public in the policy-making process, this dissertation comprises three interrelated constituent studies and adopts a mixed-methods approach with both quantitative and qualitative components.

This chapter comprehensively describes the research background and the various techniques that were used in this inquiry. Section 4.2 describes the research questions, objectives, and the structure of the three constituent studies. Section 4.3 provides several reasons for the decision to select youth, particularly university students, as the study population. Section 4.4 illustrates the method in Study 1 involving an exploratory IA focus-group workshop. Section 4.5 explains the method in Study 2 consisting of a comparative-survey study conducted in the IA focus-group workshop. Section 4.6 describes the technique in Study 3 centered on a quantitative web-based survey. The last section summarizes the research methodology.

## 4.2 Research Questions, Objectives, and Constituent Studies

Although researchers have conducted a number of studies to assess public understanding of climate change, few of these investigations have considered how humans respond to the dilemma (e.g., individual decision making, social movements, and organizational and state responses) and on the relationship between people's comprehension and their behavioral responses. To narrow this gap, this research seeks to evaluate the relationship between the public understanding of climate change and people's behavioral intentions and policy preferences with respect to mitigation of the underlying problem. Taiwan was selected as the study area because of several distinctive characteristics (see Section 3.2).

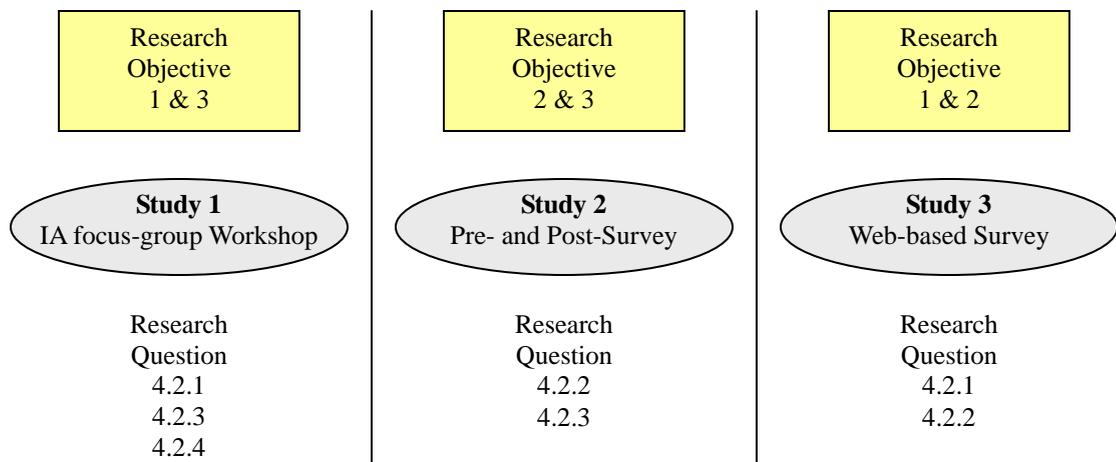
The key research question in this inquiry, therefore, is whether public scientific understanding of climate change is a necessary prerequisite for effective policy making. To address this primary research question most effectively, it is deconstructed into a number of instructive secondary questions and three primary objectives (Table 4.1).

**Table 4.1** Secondary Research Questions and Objectives

Research Question	Research Objective
4.2.1 How do people perceive climate change and what is the level of public scientific knowledge of climate change in Taiwan?	Objective 1: To examine the concerns of Taiwanese youth about global climate change in terms of their attitudes, scientific knowledge, and behavioral intentions.
4.2.2 Will a better understanding of climate science enhance people's willingness to change their behaviors and to endorse more stringent climate policies?	Objective 2: To investigate the interrelationships among these three elements (i.e., attitudes, scientific knowledge, and behavioral intentions).
4.2.3 Will an integration of scientific expertise increase the lay person's understanding of climate change effectively?	Objective 3: To assess the effectiveness of an experimental participatory exercise (i.e., the IA focus groups) in enhancing individual scientific understanding and engagement in policy making.
4.2.4 Will an integration of lay knowledge and scientific expertise effectively influence the formulation of climate policies?	

These research questions and objectives are further investigated in three constituent studies. Figure 4.1 illustrates the structure of this doctoral research containing the research questions and objectives. Study 1 was an IA focus-group workshop that anticipated addressing questions 4.2.1, 4.2.3 and 4.2.4 by interpreting the qualitative dialogue during the discussion sessions. Study 2, a quantitative survey conducted before and after the workshop, sought to investigate questions 4.2.2 and 4.2.3 by comparing the survey responses of the workshop participants. Finally, Study 3 was a quantitative web-based survey intended to address questions 4.2.1 and 4.2.2.

These three studies were not only designed to jointly address a central research inquiry, but they also mutually benefited each other. Study 2, which was executed in the same manner as Study 1, served as a pretest procedure for the larger-scale web-based survey in Study 3. The IA focus-group workshop was carried out to help interpret the quantitative data in the survey studies and also to understand how a public participation event could be designed on the basis of this experimental workshop.



**Figure 4.1** The research structure with the research questions and objectives.

## 4.3 Study Population

### 4.3.1 Introduction

The UNEP identifies nine major groups as their partners in civil society.<sup>50</sup> The organization anticipates that these groups can bring broader perspectives to environmental policy making, to help implement the organization's work program, to liaise between the UNEP and local communities, and to raise public awareness through education and grassroots campaigns (UNEP, 2009). Moreover, Agenda 21 (the action plan formulated at the 1992 Rio Earth Summit) encourages these entities to become familiar with and to actively participate in decision making for the pursuit of sustainable development (UNCED, 1992).

[O]ne of the fundamental prerequisites for the achievement of sustainable development is broad public participation in decision-making. Furthermore, in the more specific context of environment and development, the need for new forms of participation has emerged. **This includes the need of individuals, groups, and organizations to participate in environmental impact assessment procedures and to know about and participate in decisions, particularly those which potentially affect the communities in which they live and work.** Individuals, groups and organizations should have access to information relevant to environment and development held by national authorities, including information on products and activities that have or are likely to have a significant impact on the environment, and information on environmental protection measures. (UNCED, 1992, Article 23.2)

According to Agenda 21, the public's information and their involvement in environmental issues are critical to realizing sustainable development (UNCED, 1992).

To learn about people's viewpoints more thoroughly, this study specifically targets one

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<sup>50</sup> The nine major civil society groups comprise women, children and youth, indigenous peoples and their communities, NGOs, local authorities, workers and trade unions, business and industry, the scientific and technological community, and farmers (UNEP, 2009).

major stakeholder—youth. Subsection 4.3.2 discusses several reasons for selecting this group as the study population. Subsection 4.3.3 further introduces some demographic information of youth in Taiwan. Subsection 4.3.4 provides a few concluding remarks.

### **4.3.2 Why Focus on Youth?**

Youth was selected as the study population for this study because of two unique characteristics: 1) its significant representation in contemporary society and 2) its intergenerational role in implementing sustainable development. First, given that youth is a subordinate group covering a large demographic range, the UNEP has identified children and youth as one of the nine major groups in civil society. At the end of 2008, the population of children and youth accounted for 44.9% of the world's population, and the youth group (age between 15 and 24 years) constituted 17.6% of the world population (U.S. Census Bureau, 2008).<sup>51</sup> Moreover, unlike children, youth above the age of 18 years can meaningfully participate in politics and express their voices by executing citizen rights, such as casting votes.

A recent example of this political efficacy can be found in the 2008 presidential election in the US. Some political commentators have argued that young voters (between 18 and 29 years of age) were the decisive factor to President Barack Obama's electoral victory (American University, 2008; CIRCLE, 2008; CNN, 2008). While other age groups approximately split their votes between both candidates in the popular vote, more than two-thirds of young voters supported Barack Obama, which may have been a significant factor in the difference in the popular vote (Obama: 52.9% and McCain:

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<sup>51</sup> Even though each country may have different definitions, according to the United Nation's definition, children are those persons under the age of 14 and youth are those persons between the ages of 15 and 24 years (UN, 2009).

45.7%). In addition to contributing votes for Barack Obama, the candidate's campaign successfully contacted and mobilized more young people to attend public events than the McCain campaign, especially in some key battleground states (Pennsylvania: 24%; Indiana: 30%; and Nevada 35%) (PEW, 2008b).

This example suggests that by means of actively participating in politics and public affairs, the youth demographic can effectively make a difference in some political decisions. It is for this reason that this research targeted youth to investigate the group's perspective on the issue of global climate change. In addition to representing a large array of societal perspectives in the present generation, a second reason was that the youth perspective has unique implications in implementing sustainable development.

Agenda 21 points out that “[T]he involvement of today's youth in environment and development decision-making and in the implementation of programmes is critical to the long-term success of Agenda 21” (UNCED, 1992). The document further explains that the reason why the participation of youth is essential is that their unique perspectives and involvement may impact their present and future lives.

[I]t is imperative that youth from all parts of the world participate actively in all relevant levels of decision-making processes because it affects their lives today and has implications for their futures. In addition to their intellectual contribution and their ability to mobilize support, they bring unique perspectives that need to be taken into account.

(UNCED, 1992, Article 25.2)

Some may wonder how the youth group can meaningfully influence processes relevant for sustainable development. Sustainable development was famously defined as “development that meets the need of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). This commonly-quoted

definition has been criticized because of its vagueness and its difficulty to implement in terms of 1) contradictory notions and competing interpretations of “sustainable” and “development” (Dresner, 2002; Jacobs, 1991; O’Riordan, 1988); 2) the vague concept of “needs” (Pearce et al., 1989); 3) unpredictable technological limitation and capability in the future; 4) imprecise time span of the so-called “future generation.”

Regardless of these critiques on linguistic definition, the concept of sustainable development primarily involves the issue of intergenerational justice—are environmental goods and bads distributed fairly between generations? The key question then shifts to whether the objectives of protecting benefits of future generations could justify restrictions on people’s non-sustainable lifestyles.<sup>52</sup> Beekman (2004) addresses this question by interpreting sustainable development as a principle of intergenerational justice and a future-oriented green ideal on the basis of various theories, such as the savings principle (Rawls, 1993), the restraint principle (Wissenburg, 1998), the notion of chains of love (Passmore, 1980), and the idea of a transgenerational community (de-Shalit, 1995).

Although future preferences are unknowable, Rawls (1993) argues that the amount of resources that the current generation wishes to save for future people should be equal to what they wish previous generations had saved for them. Wissenburg’s (1998) restraint principle further suggests that current generations should use the environment to meet basic human needs in a way that does not reduce the opportunities of future

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<sup>52</sup> The political philosopher Avner de-Shalit (1995) specifically defines the concepts of generation and future generation. “[A] generation is a set of people who are of more or less the same age and who live at the same period in history, usually regarded as having a span of thirty years. Future generations are people who by definition will live after contemporary people are dead.”

generations. To supplement these two principles of intergenerational justice, Beekman (2004) argues for a future-oriented narrative interpretation of sustainable development. In this sense, one key motivation of people's concern about future generations comes from love for their immediate descendants (Passmore, 1980). However, de-Shalit's (1995) transgenerational community concept—in contrast to Passmore's chain of love principle—suggests that the present generation is obliged to ensure good environmental quality for posterity since they are future members of the community.

Due to the lack of interaction among generations, can the present generation understand the needs of future generations and truly take responsibility for protecting their benefits? In addition, the obligations of the present generation to the future generation fade away over time in de-Shalit's (1995) theory. Our obligations to those who exist now will be greater than our obligations to those who exist in the near future. Moreover, how should we handle obligations to people who live in the remote future? As a result, it seems inevitable that when contemporary decision makers encounter conflicts of interest among generations, the benefit of future generations would be sacrificed.

While future generations will inherit existing natural and cultural resources, they will also acquire environmental problems that are caused in the present. Since we cannot directly hear voices of future generations, their needs are likely to be compromised by present-oriented decisions. As future decision makers, children and youths seem to be the only group that exists both in the present and in the near future. Therefore, this paper argues that the role youth should play is representative of future generations.

Instead of arguing why the present generation needs to protect the future generation, it may be helpful to argue from another perspective: how future generations

can protect their own benefits. The active participation of youth indicates that it is possible to enlist the intergenerational viewpoints by future people. With the involvement of youth in the policy-making process, more sustainable outcomes can be more reasonably achieved.

Take global climate change as an example. Its anthropogenic causes and potential consequences will affect future generations. Similar to Rawls' (1993) savings principle, the resourcist view of intergenerational justice asserts the appropriate consumption and distribution of non-renewable natural resources across time (Barry, 1989). Without limiting use of non-renewable energy or compensating depleted natural resources, future generations may suffer from increasing costs of extracting remaining resources or decreasing quality of life because of exhausted natural resources. The economist Nicholas Stern (2007), author of an influential report for the UK government on the risks of deferring efforts to meaningfully reduce GHG emissions, also argues that delaying mitigation action will increase the costs of future action.

At the same time, the adverse impacts of climate change are likely to be chronic and long-term. Even if we are ultimately able to control the concentrations of all GHGs and aerosols at year 2000 levels, the IPCC (2007a) projects that the global average temperature would still increase about 0.1°C per decade. Many consequences induced by climate change are also expected to worsen by the end of the current century. Given that the current world average life expectancy at birth is 66.6 years (CIA, 2009), youth in the current generation will be most adversely affected and will face the challenges wrought by climate change far into the future. Because of this intergenerational role, it is essential to encourage youth to actively participate in formulating contemporary climate policies.

On the basis of this rationale, this study specifically focuses on this major group as the target of its investigation.

### **4.3.3 Youth in Taiwan**

The total population of Taiwan was 23,037,031 persons at the end of 2008. The population of youth (aged between 15 and 24 years) accounted for 14.1% of the national population. Among this age group, 51.8% were men and 48.2% were women (TMOI, 2008). This study particularly targeted university students to represent youth because of the high education level in Taiwan. The present education system in Taiwan supports 22 years of formal study, including preschool (2 years), primary school (6 years), junior high school (3 years), senior high school (3 years), college or university (4 years), and graduate school (4 years). After having nine years of compulsory education in primary and junior high schools, Taiwanese youth can continue their education in senior high school (aged between 15 to 17 years) and higher education at university (aged above 18 years) (TMOE, 2008).

According to the Taiwan Ministry of Education, the gross enrollment rate of higher education in 2007 was 85.3%, an amount that is higher than that recorded for other countries (e.g., United States: 82%, United Kingdom: 59%, and Japan: 58%) (TMOE, 2009a). These data suggest that having higher education is very common for Taiwanese youth. In the 2008-2009 academic year, there were a total of 1,006,102 enrolled undergraduate students in Taiwanese universities (TMOE, 2009b). Since most Taiwanese youth go to college or university, this study focuses specifically on students currently engaged in higher education—university students.

#### **4.3.4 Concluding Remarks**

Implementing sustainable development requires the active participation of various civil society groups and one of these important stakeholder constituencies is youth. The involvement of youth is especially significant because this demographic cohort represents a wide range of societal perspectives and brings unique and intergenerational viewpoints to implementing sustainable development. Global climate change is likely to have long-term adverse impacts, and such circumstances ideally demand the active participation of youth in formulating appropriate policies. In addition, because higher education is very common in Taiwan, this case study specifically focuses on Taiwanese university students as the study population.

### **4.4 Study 1: IA Focus Group Workshop**

#### **4.4.1 Introduction**

As discussed in Section 4.2, this doctoral research seeks not only to evaluate the relationship between the public understanding of global climate change and people's behavioral intentions and policy preferences in taking actions to mitigate the problem, but also to explore what role scientific expertise can play in bridging civic understanding and developing mitigation responses. Study 1, one of the three constituent studies, aims to create an opportunity for integrating perspectives from experts and youth.

This chapter provides a comprehensive explanation for Study 1 involving the facilitation of an IA focus-group workshop. This experimental participatory exercise was crucial to the success of this doctoral research because it also involved Study 2 and three secondary research questions. By interpreting the qualitative dialogue during the sessions,

Study 1 foreshadowed efforts to address the following research questions (also see Table 4.1).

- 4.2.1 How do people perceive climate change and what is the level of public scientific knowledge of climate change in Taiwan?
- 4.2.3 Will an integration of scientific expertise increase lay people's understanding of climate change effectively?
- 4.2.4 Will an integration of lay knowledge and scientific expertise effectively influence the formulation of climate policies?

Subsection 4.4.2 discusses the methodology underlying the IA focus groups. Subsection 4.4.3 highlights the procedures for recruiting respondents and conducting the workshop. Subsection 4.4.4 describes the roles of the moderators and experts who were involved in this study. Subsection 4.4.5 explains the design of the discussion sessions. Subsection 4.4.6 explains the method of data analysis and interpretation. Subsection 4.4.7 concludes with a few remarks.

#### **4.4.2 IA Focus Groups**

To effectively evaluate the integration of science and the public in the policy-making process, this study employed an interdisciplinary research method involving the use of IA focus groups. This technique has been adopted in many social scientific studies of global climate change over the past decades (e.g., Darier & Schüle, 1999; Darier et al., 1999a, 1999b; Kasemir et al., 2000a; Stoll-Kleemann et al., 2001; Puy et al., 2008). The concept of IA focus groups combines two research techniques: integrated assessment and focus groups. Both of these approaches are described below.

First, the idea of IA was developed in the 1990s because of the need to provide synthesized information from various disciplines to policy makers for large-scale

environmental issues such as global climate change (Weyant et al., 1996). In addition, to integrate a variety of different areas of scientific expertise, it has proven necessary to incorporate the lay public in the policy-making process in democratic societies. To bridge the gap between the science of global climate change and relevant lay perspectives, researchers developed a method that relies on the participation of ordinary citizens in IA. The participatory dimension of IA, also called PIA, is designed to enhance interactions between experts (scientists and policy actors) and the lay public. One of the most common participatory procedures in IA is the focus-groups method (Kasemir, et al., 1999; Dürrenberger, et al., 1999).

Focus groups are a research technique that has been commonly used since World War II (Merton & Kendall, 1946; Merton, 1987). The method was first widely accepted in the pragmatic market-research community as a way to understand consumers' concerns toward commercial products and services (Krueger & Casey, 2009). It was not until the 1980s that the academic and nonprofit communities began to adopt this research method. Unlike individual interviews that use a predetermined questionnaire with closed-ended response choices, focus groups derive from two social scientific research methods: interviews and group discussions.

These two methods in combination contribute to a significant advantage for focus groups, namely that they encourage intragroup interactions. Kasemir et al. (2003) pointed out that “the advantage of focus groups compared to individual interviews is that focus groups intrinsically exhibit social dynamics that allow for interactions between multiple perspectives, instead of just compiling different perspectives by individual questionnaires or interviews.” This means that new ideas are possibly generated by group interaction.

Focus groups typically include five features: (1) a small group of people with (2) similar characteristics (3) who provide qualitative data in (4) a focused discussion to (5) help understand the topic of interest (Krueger & Casey, 2009). The primary purpose of the methodology is for the investigator to listen and to gather information from this small group of perspectives. It is recommended that focus groups should not be used when organizers or researchers intend to educate participants or need a conclusion or a consensus (Krueger & Casey, 2009).

In addition, information derived from conventional focus groups is not sufficient to provide input on complex societal or political issues. Therefore, IA focus groups adjust the general method to a longer and more structured discussion process that serves as an intermediary forum between public debates and private decision making (Kasemir et al., 2003). By incorporating experts into the process of interaction, the purpose of IA focus groups is not only to listen and to gather information, but to enable participants to make informed decisions and have a more effective discussion.

#### **4.4.3 Procedure and Recruitment**

With some modifications of the IA focus-group method described by Kasemir et al. (2003), a one-day workshop was organized in the summer of 2008. University students were assembled to discuss the issue of global climate change and the responses that have thus far been undertaken by the Taiwanese government. To offer a comfortable setting for participants, the workshop was co-organized with the Association of Taiwanese Public Policy Development and sponsored by the National Youth Commission. To clearly promote the purpose of the event, the activity was named “*The Youth Participatory*

*Workshop for Anti-warming<sup>53</sup> Policies.*” The study aimed to recruit approximately twenty participants so a small-scale approach was developed to advertise the workshop.

Messages regarding the focus-group workshop were sent via electronic mail to several key Taiwanese youth organizations (e.g., student clubs and non-profit organizations) with specific instructions for them to forward this information to their members. Details regarding the workshop were also posted on several appropriate web sites such as Civil News Platform and Bulletin Broad System (BBS), a system commonly used by Taiwanese university students. Prospective respondents—primarily university students—interested in this issue applied to participate in advance. No specific screening criteria were used to select respondents for the workshop. Because these young adults voluntarily registered for the workshop with no monetary compensation, it is assumed that they had a relatively high level of personal concern about global climate change and thus demonstrated a comparatively high willingness to participate in public policies.

A quantitative survey was administered at both the start and conclusion of the workshop to assess the differences in the participants’ levels of scientific understanding and personal responses (i.e., personal behaviors and policy preferences) (for the complete methodology of the pre- and post-survey, see Section 4.5). In addition to the survey, a supplementary qualitative investigation was carried out to analyze the content and the interactive process of the focus-group discussion with the consent of the participants. The ensuing discussion was video recorded and transcribed to written documents. The transcript was analyzed qualitatively in the data-analysis process. This qualitative

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<sup>53</sup> The term “Anti-warming” (pronounced as “Kang-Nuan-Hua”) was chosen because in Taiwan “global warming” is a more commonly used term than “climate change.” Many climate-protection campaigns have used the term “anti-warming” to convey their concerns to the public.

information provided a complementary tool to interpret the quantitative data collected from the surveys. These two techniques were used to assess the effectiveness of stakeholder participation in formulating domestic climate policies.

#### **4.4.4 Moderator and Expert**

To conduct a more efficient discussion, participants were divided into two small groups (Group A and Group B). Four experienced facilitators were hired to serve as skilled discussion leaders. Although these moderators did not have any specific environmental background, they were trained by going through a guidebook covering discussion principles and model questions and answers prior to the workshop.<sup>54</sup> One moderator and one assistant moderator were assigned to each focus group. The moderator was responsible for leading the discussion (e.g., encourage speaking and stimulate interaction) and to keep the proceedings on track. While the whole process was video recorded, the assistant moderator operated the video camera, tracked discussion times, and wrote down key points raised by each group member to simplify the transcription process.

Two experts were invited to provide scientific information about climate change to both focus groups. Dr. Huang-Hsiung Hsu, an atmospheric scientist from the Department of Atmospheric Science at National Taiwan University (NTU), explained the science of the greenhouse effect and the adverse impacts of climate change. Dr. Tze-Luen Lin from the Department of Political Science at NTU discussed international politics and policy making (e.g., Kyoto Protocol), as well as Taiwan's energy use, CO<sub>2</sub> emissions, and climate policies.

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<sup>54</sup> The training and the guidebook was conducted and prepared by the author.

#### 4.4.5 Session Design

The technique of IA focus groups structures the process into three phases: participants' spontaneous expressions, their assessment of current research findings as motivated by expert input, and synthesis of informed participants' conclusions (Kasemir et al., 2003). The whole process is optimally designed for five sessions lasting approximately 2.5 hours per session. Considering the feasibility of execution (e.g., difficulty to gather participants many times under financial constraint), this study condensed and shortened the original design. Based on the same tripartite phase structure, three primary sessions were conducted as part of a one-day, seven-hour workshop (Table 4.2).

**Table 4.2** Agenda and Session Description of the IA Focus-Group Workshop

Session	Time (min)	Session Description
Opening	30	Introduction and pre-test survey administration
Session 1	60	<ul style="list-style-type: none"> <li>• Self-introduction</li> <li>• Sharing of personal understanding of climate change in causes and consequences and anthropogenic contribution</li> </ul>
Session 2	45	Expert Presentation 1 (Dr. Huang-Hsiung Hsu): Scientific phenomenon, cause, and impacts of global climate change
	45	Expert Presentation 2 (Dr. Tze-Luen Lin): Global climate change and Taiwan's responses to global climate change
Session 3	90	In-depth discussion: <ul style="list-style-type: none"> <li>• Humans' responsibility to resolve global climate change</li> <li>• The responsibility of industrialized and developing countries</li> <li>• Should Taiwan ratify the Kyoto Protocol?</li> </ul>
	90	Group consensus building: Would you support this policy? <ul style="list-style-type: none"> <li>• Group A: Energy Conservation and Carbon Reduction Program</li> <li>• Group B: Greenhouse Gas Reduction Bill (draft)</li> </ul>
Closing	30	<ul style="list-style-type: none"> <li>• Group A and Group B Presentation</li> <li>• Post-test survey administration</li> </ul>

Table 4.2 summarizes the agenda and each session of the IA focus-group workshop. The event began with a 30-minute opening during which the schedule of the

day was introduced and the participants completed the pre-test survey on their attitudes about global climate change prior to being exposed to the expert input. The first session (1 hour) consisted of self-introductions of group members and the sharing of personal understandings about climate change. The self-introductions aimed to help group members relax and to build a friendly atmosphere. The participants were then asked to describe their personal impressions of climate change, to discuss the extent to which they recognized it as a problem, and to identify its causes and consequences.

The second session of the workshop (1.5 hours) consisted of two expert presentations. The first expert treatment was designed to cover fundamental information about climate change from a physical science perspective. The presenter, Dr. Huang-Hsiung Hsu, described the science of the greenhouse effect, the natural and anthropogenic causes of planetary warming, the adverse impacts and the scientific evidence of ongoing processes, and the future projections of global temperature and sea-level increases.

The second expert delivered information about climate change from a policy science perspective. The presenter, Dr. Tze-Luen Lin, explained the significance of a series of international meetings (e.g., COPs) and treaties (e.g., UNFCCC, Kyoto Protocol), and CO<sub>2</sub> emissions, energy use, and mitigation strategies in Taiwan. Followed by each lecture-type presentation was a 15-minute question-and-answer period during which the participants were able to interact with the invited experts.

After the participants received the scientific and policy-relevant expertise in the second session, the last session (3 hours) anticipated the participants making an informed assessment by having in-depth discussions and building a group consensus. The

discussion proceeded in two stages: general climate issues (1.5 hours) and domestic climate policy (1.5 hours). In the first stage, they were asked to discuss some issues:

- Are humans responsible for inducing climate change? Should humans take responsibility to resolve the problem?
- Who should take responsibility? Industrialized or developing countries?
- Who should take responsibility in Taiwan? Industries or the general public?
- Should Taiwan ratify the Kyoto Protocol?<sup>55</sup>

In the second stage, each group discussed one domestic climate policy (mitigation strategy) and tried to reach a group consensus—whether to support the policy or not. The strategy discussed by Group A was a voluntary-based governmental initiative called “Energy Conservation and Carbon Reduction Program.” Group B discussed a mandatory policy being debated at the time in Taiwan—the “Greenhouse Gas Reduction Bill (Draft)” (see Section 3.5 for a detailed introduction).

IA focus-groups members are generally requested to make their concluding assessment via the production of a written citizens’ report in the last phase (Kasemir et al., 2003). Due to the constraints on scheduling, the participants in this study were not able to complete a written group report. Nevertheless, each group was required to make an oral presentation of their consensual position during the closing. The end of the workshop was marked by the distribution of a post-test survey that inquired about their attitudes about climate change after receiving expert input and interacting with their fellow participants.

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<sup>55</sup> Since Taiwan is not a UN member, it has been excluded from most formal processes of international negotiation, including the Kyoto Protocol. Nevertheless, some political commentators have argued that Taiwan should begin to reduce its GHG emissions because it might become subject to mandated reduction targets along with other newly-industrialized nations (e.g. South Korea) during the post-Kyoto period.

#### **4.4.6 Data Analysis**

The discussion session of each group was video recorded and transcribed to written documents. It is difficult to quantify the participants' responses in a group discussion because once a point is mentioned by a group member; it is unlikely another member would repeat the same point. In addition, regardless of the moderators' efforts to encourage every group member to share his/her opinion, it is inevitable that some participants were more vocal and some were more silent. As a result, the transcript was primarily analyzed qualitatively. Subsection 5.2.2 presents a number of interesting group dialogues which were key discussion topics in session 1 and session 3 (see Subsection 4.4.5). These dialogues are highlighted either because the focus-group participants raised unique viewpoints (e.g., different and new ideas reviewed from preceding literature) or because some patterns were observed (e.g., agreement or disagreement with fellow group members which led to further in-depth interactions).

#### **4.4.7 Concluding Remarks**

This study employed the technique of IA focus groups that has been commonly used in many interdisciplinary studies involving complex issues at the interface of science and public policy. To understand Taiwanese university students' perspectives about the issue of global climate change and to assess the effectiveness of a participatory exercise in enhancing scientific understanding and in formulating climate policies, a modified one-day IA focus-group workshop was organized in 2008. The workshop consisted of three sessions: participants' spontaneous expressions, expert presentations of current research findings, and synthesis of informed participants' conclusions.

## 4.5 Study 2: Pre- and Post-Survey

### 4.5.1 Introduction

Study 2, the second of the three constituent studies in this doctoral research, consisted of a comparison survey study carried out in the IA focus-group workshop in Study 1. The purpose of this study was to learn how the expert-integrated focus-group workshop influenced the participants' understanding of the issue of global climate change. To accomplish this aim, a standardized multiple-item survey was designed and administered at the beginning and end of the workshop to collect quantitative data that could be used to assess potential changes in participants' attitudes, scientific knowledge, behavioral intentions, and policy preferences. This chapter explains the methodology of the pre- and post-survey in detail including the design of the instrument and its administration. By comparing the survey responses of the workshop participants, the study anticipated addressing the following research questions (also see Table 4.1).

- 4.2.2 Will a better understanding of climate science enhance people's willingness to change their behaviors and to endorse more stringent climate policies?
- 4.2.3 Will an integration of scientific expertise increase lay people's understanding of climate change effectively?

Subsection 4.5.2 summarizes the historical development of survey research methods in the social sciences. Subsection 4.5.3 discusses two different approaches that have been commonly used to investigate people's environmental concern and introduces the combined approach that was applied in this study. Subsection 4.5.4 highlights the procedure used to administer this survey. Subsection 4.5.5 describes the questionnaire construction including the structure, dimension, variables, and questions. Subsection 4.5.6 explains how data was analyzed. Subsection 4.5.7 concludes this section.

#### 4.5.2 Survey Research Method

Babbie (1990) points out that contemporary survey research is a product of American researchers in this century and it grew out of significant developmental efforts by three sectors of American society: the Bureau of the Census, the commercial polling firms (e.g., Gallup Poll), and the activities of some universities (e.g., Bureau for Applied Social Research at Columbia University). Countless survey experiences in decennial censuses, product marketing, and political polling have refined the technique with respect to sampling, question wording, and data collecting. Differing from a census that generates basic characteristic data of the entire population, a survey is designed to examine a fraction of a population by sampling. Even though a census covers extensive perspectives of the population, the information it provides is not sufficiently specific enough for researchers in many disciplines. To fill the information gaps, special-purpose surveys have been commonly developed in the United States since the 1930s (Fowler, 2009).

Survey research is a method that uses a standardized questionnaire to collect quantitative information of subjective perceptions of the study population from a sample. The technique was first used to measure public opinions for news articles (media), to evaluate political perceptions (politics), and to assess consumptive preferences (business). However, the method has now been applied in numerous areas of public policy and the study of social problems (Fowler, 2009). It is suggested that a survey can be an effective research tool when combined with other methods (Babbie, 1990). This is why this doctoral research employed a qualitative IA focus-group method and a quantitative survey method to comprehensively appraise the concern among Taiwanese youth regarding the issue of global climate change.

### 4.5.3 Survey Approach

Survey research, an early example of empirical social science research, has been commonly used to measure people's overall level of *environmental concern*, a term also synonymous with *environmental attitudes* (Ester, 1981). Dunlap and Jones (2002) define environmental concern as “the degree to which people are aware of problems regarding the environment and support efforts to solve them and/or indicate a willingness to contribute personally to their solution.” To measure a person's environmental concern a clear conception is necessary. Thus, Dunlap and Jones (2002) further clarify the concept of environmental concern with two components: “environmental” and “concern” parts.

The “environmental” part of environmental concern refers to a particular environmental issue about which the investigator would like to understand how the study subject thinks. The term “environment” has multiple meanings. It can simply mean biophysical phenomena or it can indicate the interactive relationship between the biophysical environment and human activities. A clearly defined environmental issue is essential to measure people's concern effectively. The chosen issue can be studied at various levels of generality (a specific or a general issue), at differing geographical scales (at the local or global level), and in differing time frames (past, present, or future) (Dunlap & Jones, 2002). For example, global climate change is considered a specific environmental issue that may cause long-term impacts at the planetary level.<sup>56</sup>

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<sup>56</sup> The level of generality is a relative concept. For example, a study that focuses on environmental problems is more general than a study of pollution; a study of pollution is more general than a study of air pollution. Even though global climate change is an inherently complex problem that involves various underlying environmental issues, such as air pollution, energy use, water resources, and so forth, it has been recognized as a significant environmental issue in and of itself. Thus, this study considers it as a specific environmental issue.

In addition to the environmental part, the “concern” component of environmental concern suggests an expression of unease about the chosen environmental issue. It is often conceptualized and investigated through two approaches: a social-psychological theoretical approach and a practical policy-relevant approach (Van Liere & Dunlap, 1981). The theoretical approach, based on attitude theory, usually investigates the study subjects’ knowledge of the nature of beliefs, attitudes, intentions, and behaviors and their theoretical and empirical relationships at a micro or individual level. The theoretical study generally consists of four dimensions: cognitive, affective, conative, and behavioral expression indicators (Dunlap & Jones, 2002).

In contrast, the policy approach typically investigates the study subjects’ understanding of environmental problems and their policy implications at a macro level or in terms of their structural scope. The central question centers on how the study subjects’ think about the environmental problem in terms of perceived seriousness and causes of such problems, preferred responsible sectors, and individual support for various solutions (Dunlap & Jones, 2002). Table 4.3 illustrates a detailed comparison of these two approaches in terms of scope, emphasis, and investigation indicators.

A large number of studies have employed the survey research method to measure people’s concern about various climate-related issues (e.g., Read et al., 1994; Bord et al., 2000; Lazo et al., 2000; Seacrest et al., 2000; Sterman & Sweeney, 2002; Shackley et al., 2005). For instance, Shackley et al. (2005) used the policy approach to measure British citizens’ perception of an off-shore CO<sub>2</sub> capture and storage strategy. Bord et al. (2000) deployed the theoretical approach to measure Americans’ attitudes, knowledge and behavioral intentions of global warming and the interrelationships between each facet.

**Table 4.3** Comparison of the Two Approaches of Environmental Concern

	<b>Theoretical Approach</b>	<b>Policy-Relevant Approach</b>
<b>Scope</b>	Micro/individual-level	Macro/structure-level
<b>Emphasis</b>	The role of individuals' behaviors in creating and solving environmental problems (Attitude Theory)	The role of social institutions, environmental policies, and collective action in creating and solving environmental problems
<b>Investigation Indicators</b>	<ul style="list-style-type: none"> <li>• Cognitive expression: accurate environmental knowledge, personal environmental belief</li> <li>• Affective expression: personal feelings and emotions</li> <li>• Conative expression: personal intentions, commitments, and willingness to perform individual actions or to support public policy proposals</li> <li>• Behavioral expression: actual or reported personal environmental behaviors, public environmental behaviors</li> </ul>	<ul style="list-style-type: none"> <li>• Individuals' perception of the seriousness of the problem</li> <li>• Individuals' perceived causes of the problem and blame among various stakeholders</li> <li>• Individuals' anticipated sectors to have responsibility for solving the problem</li> <li>• Individual's preferred solutions</li> <li>• Individuals' support for governmental regulations</li> <li>• Individuals' expressed willingness to engage in collective actions</li> </ul>

Source: Dunlap and Jones (2002)

It has become increasingly common for researchers to conduct policy-relevant studies that use indicators of the theoretical approach or social-psychological theoretical studies that include policy-relevant variables. Thus, this study was designed to employ both approaches in combination to investigate individuals' understanding of global climate change, their responses to this issue, and to explore their interrelationships.

#### **4.5.4 Administration**

One critical process of conducting social scientific studies that involve human subjects is obtaining a research approval from the relevant Institutional Review Board (IRB). This ethical procedure is designed to protect subjects from risks to which they may be exposed during their participation as a respondent. This doctoral research also completed this process by submitting the research protocol to the IRB at New Jersey Institute of

Technology (NJIT). The protocol was first approved in June 2007 and then renewed in July 2008. All participants in this study received a consent form that explained their rights as a research subject. By signing the form, the subject agreed to be involved in the study. Additionally, to obtain a better response rate and to avoid misunderstandings of the questions, the survey instrument was further translated into Chinese, the native language of the respondents in Taiwan.<sup>57</sup>

The sample targets of the pre- and post-survey study were the young adults who participated in the IA focus-group workshop in the summer of 2008 so the sampling process was carried out at the same event. As highlighted in Subsection 4.5.1, the same instrument was administrated at the beginning and end of the workshop. Participation in the survey was completely voluntary and included a separate consent form. The participants needed to sign two consent forms to indicate that they agreed to participate in both IA focus-group workshop and pre- and post-survey. In addition, the survey was not anonymous, so the pre- and post-responses could be matched and compared.

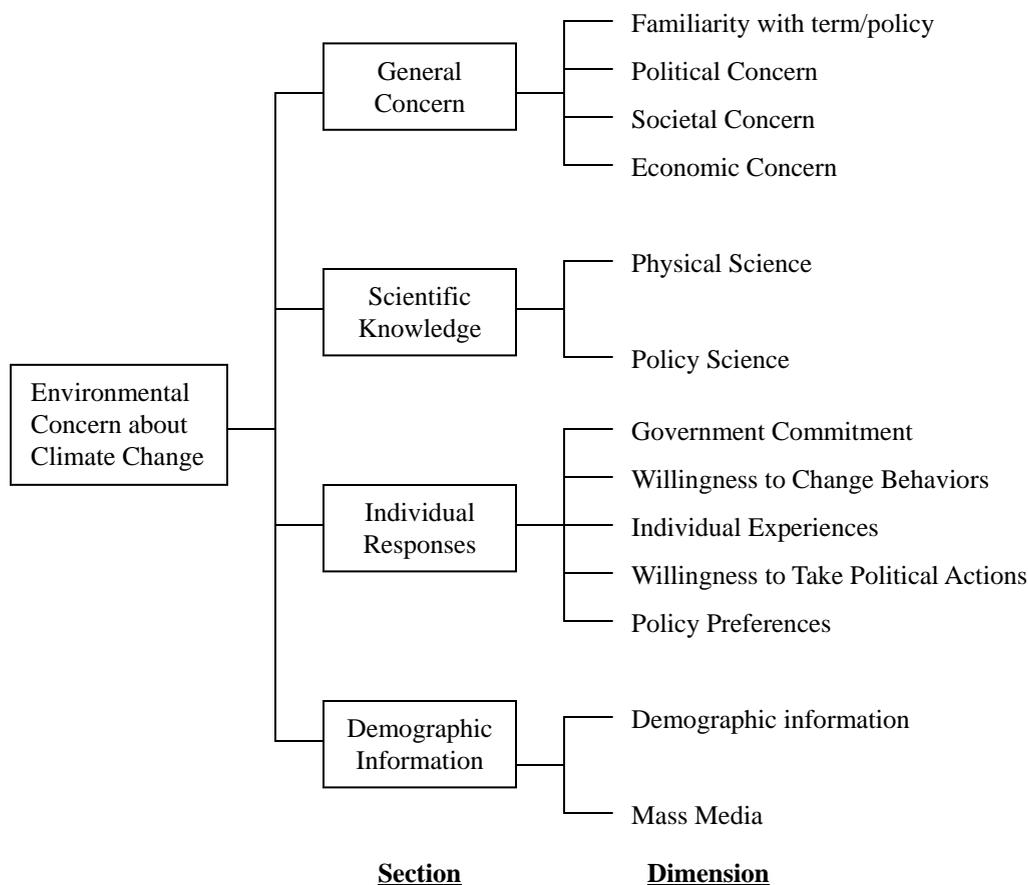
#### **4.5.5 Questionnaire Design**

##### *Structure of the Instrument*

As discussed in Section 4.5.3, this study adopted a combined approach to investigate Taiwanese university students' concern about climate change such as their general attitudes, scientific knowledge, and behavioral intentions. The standardized survey instrument with multiple-items in eight pages had four sections and numerous dimensions (Figure 4.2).

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<sup>57</sup> The translation in the survey instrument and the following data analysis was done by the author. Nevertheless, the consent form that was submitted to the IRB was bilingual.



**Figure 4.2** The structure of the pre-and post-survey instrument in sections and dimensions.

### Construction of Variables and Questions<sup>58</sup>

The first section “General Concern” comprised four dimensions with a total of fourteen questions designed to assess the respondents’ general attitudes about global climate change and their understanding of various policy implications (Table 4.4). In the first dimension (Q1.1) each respondent was asked to self-evaluate his/her level of familiarity with three different terms (e.g., global climate change) and two climate policies (e.g.,

<sup>58</sup> A variable is a logical grouping of attributes. For example, the variable “gender” is made up of the attributes “male” and “female.” A dimension is an aspect of a variable. For example, the variable of “religiosity” may belong to the “belief dimension” (Babbie, 1990).

Kyoto Protocol) along a continuum scale (from very familiar to not familiar at all) (see the complete survey instrument in Appendix A).

**Table 4.4** Dimension, Variable, and Question Number of Section I (General Concern)

<b>Dimension</b>	<b>Variable</b>	<b>Question No.</b>
Familiarity	Familiarity with terms and policies	Q1.1
Political concern	Problem recognition	Q1.2; Q1.3; Q1.4; Q1.5
	Political priority	Q1.7; Q1.8
Societal concern	Blame for the problem	Q1.6
	Responsibility for solving the problem	Q1.9; Q1.10
	Personal relevancy index	Q1.11; Q1.12; Q1.13
Economic concern	Economic tradeoff	Q1.14

The second dimension that examined the respondents' political concern comprised two variables: problem recognition and political priority. The variable of problem recognition was measured by four questions that asked how the respondents perceived global climate change (Q1.2, Q1.3), whether they recognized it as real (Q1.4), and how much they were concerned about the adverse effects (Q1.5). In addition, the respondents were asked to select three prioritized public policies (Q1.7) and three prioritized environmental issues (Q1.8) for the Taiwanese Government's actions to indicate their perceived political priority of climate change.

The third dimension, "societal concern," aimed to investigate how the respondents thought about the relative responsibility of various societal groups in accordance with three variables: blame for the problem, responsibility for solving the problem, and personal relevancy. The respondents were asked to self-evaluate their levels of agreement with whether human activities were the key driving force to global climate change on a

five-point scale (strongly agree: 5; strongly disagree: 1) (Q1.6).<sup>59</sup> They also identified major economic/industrial sectors that should bear responsibility for solving the problem (Q1.9, Q1.10).

The last variable was a composite measure “Personal Relevancy Index,” with which the respondents assessed their relationship to global climate change in terms of personal contributions, impacts, and actions (Q1.11, Q1.12, Q1.13). These three questions were designed in an “agree-disagree” format with a five-point scale (Box 1). The higher the index score, the more the respondents regarded global climate change as a relevant issue in their lives. It was noteworthy that Q1.13 was reversely worded which means a strong disagreement with the statement would be recorded as 5 points.

Box 1) Question Example – Q1.11, Q1.12, Q1.13					
Provide your assessment of the following statement:					
Q1.11 My daily activities contribute to global climate change.					
Q1.12 Global climate change may impact me personally in my lifetime.					
Q1.13 The problem of global climate change is so overwhelming that it is really beyond the control of a young person such as me. (Reversed worded)					
Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Do Not Know
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Finally, the dimension of economic concern was constructed so as to be able to understand the respondents’ opinions about difficult trade-offs between environmental

<sup>59</sup> A number of items in this instrument were formatted as Likert-scale type questions, mostly with a scale of five points. These items were phrased as a statement for the respondents to rate and to assess their level of personal agreement, willingness, and support. Higher scores corresponded to higher levels of agreement, willingness, and support. Take the agree-disagree type of question as an example. A strong disagreement was scored as 1 point, a neutral position (neither agree nor disagree) was scored as 3 points, and a strong agreement was scored as 5 points. In other words, a score of 5 means the respondent agreed with the item very much.

protection and economic objectives (Q1.14). One key point that needed to be emphasized was that several questions in this section had an additional option “Do not know.” It allowed those who were unwilling to answer the question to select an opinion-free option instead of forcing an invalid answer that would have likely adversely affected the dataset.

The goal of the second section was to investigate respondents’ scientific knowledge of climate change using two dimensions: physical science and policy science. Table 4.5 highlights the dimension of physical science including a number of variables pertaining to—whether the respondents could identify causes, consequences, and mitigation strategies of climate change correctly (Q2.1, Q2.2, Q2.3); whether they had correct knowledge of greenhouse-effect phenomena (Q2.4.1, Q2.4.2); whether they were familiar with current scientific observations (Q2.4.3, Q2.4.4, Q2.4.5, Q2.4.6); and their future projections of global climate change (Q2.4.7, Q2.4.8, Q2.4.9). Additionally, the policy science dimension employed three variables to examine respondents’ understanding about the current reality of some policy-relevant issues: international treaties (Q2.4.10, Q2.4.11), Taiwan’s energy use (Q2.4.12), and Taiwan’s GHG emissions (Q2.4.13, Q2.4.14, Q2.4.15).

**Table 4.5** Dimension, Variable, and Question Number of Section II (Scientific Knowledge)

Dimension	Variable	Question No.
Physical Science	Identification of causes, impacts, mitigations	Q2.1; Q2.2; Q2.3
	Greenhouse effect phenomena	Q2.4.1; Q2.4.2
	Scientific observation	Q2.4.3; Q2.4.4; Q2.4.5; Q2.4.6
	Future projection	Q2.4.7; Q2.4.8; Q2.4.9
Policy Science	International treaty	Q2.4.10; Q2.4.11
	Taiwan energy use	Q2.4.12
	Taiwan GHG emissions	Q2.4.13; Q2.4.14; Q2.4.15

In the first three questions of this section, the respondents were asked to identify correct causes, impacts, and mitigation strategies from a list of ten choices comprising both actual and bogus queries—a modified version from a survey by Bord et al. (2000).<sup>60</sup> If a respondent successfully identified the correct answer (or did not select a bogus option), the item was recorded as a correct answer. The overall score on a particular item depended on the number of correct answers the respondent identified (see Box 2).

### Box 2) Question Example – Q2.2 and Q2.4

Q2.2 Select from the following list the potential consequences that are contributing directly by global climate change. <You may select more than one option>

- Increasing average global air and ocean temperatures
- Increasing chances of skin cancer due to exposure to excessive ultraviolet light (bogus)
- Increasing frequency and intensity of extreme weather
- Increasing pesticide residues in food products (bogus)
- Increasing radioactive waste (bogus)
- Change in precipitation volume (i.e., increasing flood and drought, water resource shortage)
- Decreasing agricultural productivity
- Decreasing biodiversity
- Decreasing vector-borne diseases (bogus)
- Global average sea level rise
- Melting glaciers and ice cap in mountain and polar region

Q2.4 Yes or No question. Please indicate whether each of the following statements is correct. Do not worry if you do not know the answer as this is not a test. If you do not understand the item, you may leave it blank.

	Yes	No	Do Not Know
Q2.4.1 The greenhouse effect is a natural phenomenon that moderates the earth's average surface temperature within a relatively comfortable range.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q2.4.7 If the global concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, further warming could be stopped. ( <u>bogus</u> )	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q2.4.13 The major contributor of carbon dioxide emissions (including direct emission and indirect electricity consumption) in Taiwan is the industrial sector.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

<sup>60</sup> Bord et al. (2000) asked respondents to indicate whether they thought each item was a major cause or a minor cause of global warming or not a cause at all. These items were either actual causes (e.g., use of coal and oil by electric companies) or bogus causes (e.g., use of chemicals to destroy insect pests).

The respondents were then asked to assess the correctness of a set of fifteen factual scientific statements that also included six false queries. In addition to true or false options, an extra option “Do not know” response was inserted to discourage guessing. However, selection of this option was recorded as an incorrect answer during the scoring phase. Despite the different formats used in Q2.1-Q2.3 and Q2.4, these scientific questions have the same dichotomous concept—the respondents perceived either correct or incorrect responses to each scientific statement. Box 2 illustrated question examples for Q2.2 and Q2.4.

The third section sought to understand respondents’ individual responses to climate change in five dimensions. The first dimension investigated respondents’ subjective viewpoints about whether Taiwan should commit to reduce its GHG emissions in a “Yes or No” format (Q3.1). They were further asked about their reasoning of such commitments in a contingent design. Respondents that selected “Yes” in Q3.1 would proceed to Q3.2 and respondents that selected “No” in Q3.2 would proceed to Q3.3.

The second aspect requested respondents to self-rate their level of willingness to change personal behaviors to favor climate-protection actions with respect to energy use, transportation practices, and general consumption patterns (Table 4.6). This set of questions (Q3.4) was also modified from Bord et al.’s (2000) study.<sup>61</sup> A rating-scale table was designed to enable the respondents to rate the potential changes of each action in accordance with a five-point scale (willing: 5; unwilling: 1). The respondents then indicated their own experiences of having taken certain actions (e.g., use of public

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<sup>61</sup> Bord et al. (2000) asked respondents to express how likely they would be to take certain voluntary actions (e.g., carpool and drive less; replace older appliances) along a five-point Likert scale.

transportation) in Q3.5 with five options (frequently, sometimes, rarely, never, and do not know).

**Table 4.6** Dimension, Variable, and Question Number of Section III (Individual Responses)

Dimension	Variable	Question No.
Government commitment		Q3.1; Q3.2; Q3.3
Willingness to change behaviors	Energy use	Q3.4.1; Q3.4.2
	Transportation	Q3.4.3
	Green consumption	Q3.4.4; Q3.4.5; Q3.4.6
Individual experiences	Experience	Q3.5
Willingness to take political actions	Political actions	Q3.6.1; Q3.6.2; Q3.6.3
	Environmental movement	Q3.6.4; Q3.6.5
Policy preferences	Mitigation Policy Preferences Index	Q3.7

The fourth dimension also used a five-point Likert scale (Q3.6) to assess respondents' willingness to participate in certain political and social actions that could motivate the Taiwanese government to reduce the island's GHG emissions (e.g., attend a public hearing, join an environmental group). The last dimension, revised from Bord et al.'s (2000) study,<sup>62</sup> examined the respondents' personal support for climate policies of various intensities (Q3.7). These possible initiatives represented a wide range of mitigation strategies, including a green industrial development plan, a cap-and-trade law, taxes and other economic incentives, a reforestation program, and a nuclear energy development plan. Box 3 illustrates question examples for Q3.2 and Q3.7.

The survey concluded with a set of questions designed to collect demographic information (i.e., age, gender, academic major, and educational status). Two

<sup>62</sup> Bord et al. (2000) asked respondents to indicate how they would vote regarding several hypothetical governmental initiatives in a national referendum (e.g., an energy-use tax on businesses, a rainforests-preservation program) in a continuum of definitely yes, probably yes, probably no, and definitely no.

supplementary questions about information sources and film-viewing experiences were asked at the end.

### Box 3) Question Example – Q3.2 and Q3.7

Q3.2 Taiwan should reduce its greenhouse gas emissions because the country \_\_\_\_\_

<You may select more than one option>

- May face trade sanctions from the rest of the world.
- Has relatively high greenhouse gas emissions per capita (per person).
- Will be affected by the adverse impacts resulting from global climate change.
- Will benefit economically from action to reduce its emissions in the long term.
- Is a member of the global community and does not have a moral right to destroy the environment.
- Others: \_\_\_\_\_

Q3.7 Below is a list of several possible initiatives that could help to reduce emissions of carbon dioxide into the atmosphere. Please fill in the response that most closely reflects your views in terms of your support for each activity.

	Strongly Support	Support	Neutral	Oppose	Strongly Oppose	DK
Q3.7.1 Encourage the development of less pollution and energy intensive industries by shifting government subsidy programs	<input type="checkbox"/>					
Q3.7.6 Encourage the planting of trees	<input type="checkbox"/>					
Q3.7.7 Support the use of nuclear power as an alternative source of energy	<input type="checkbox"/>					

#### 4.5.6 Data Analysis

The responses collected in the pre- and post-surveys were recorded in Excel spreadsheets.

The quantitative data were presented in two ways: a direct value or score of the item and a frequency (i.e., the percentage of responses in certain options). The potential changes of the pre- and post-responses were determined by the direct comparison of the value of a variable or the average score of a scale. Due to the small sample size (less than 30), this

study did not administer statistical analyses to verify the statistical significance of the changes of the pre- and post-responses (e.g., the paired T test).

#### **4.5.7 Concluding Remarks**

This study used a standardized survey, the most common social science research method, to collect quantitative information of subjective perceptions from the young adults who participated in the IA focus-group workshop. The purpose of this study was to learn how the expert-integrated focus-group workshop influenced the participants' understanding of climate change. Therefore, by administering the same survey instrument at the beginning and end of the workshop, not only could the study collect data on participants' concern about climate change, the comparison of the pre- and post-survey responses could also assess potential changes of the participants' overall level of understanding.

In addition, this study employed both theoretical and policy approaches to investigate Taiwanese university students' overall concern (general attitudes, scientific understanding), individual responses (behavioral intention and policy preferences) toward the issue of global climate change, and to explore the interrelationships. The multiple-item survey instrument was constructed with a structure consisting of four sections—General Concern, Scientific Knowledge, Individual Responses, and Demographic Information. Several types of questions were used in the survey. For example, a dichotomous (true or false) format was chosen to quantify the respondents' scientific knowledge. The second series of questions comprised multiple-choice questions that allowed respondents to select either single or multiple answers. The third category of questions used a Likert-scale format with which the respondents could rate their level of personal agreement, willingness, and support.

## 4.6 Study 3: Web-based Survey

### 4.6.1 Introduction

Study 3 was a standardized survey study conducted in November 2008. This survey sought to investigate Taiwanese university students' overall level of concern about climate change and to explore the hypothetical relationship between scientific knowledge and individual responses (i.e., willingness to endorse different climate protection actions and policies). To collect data from a larger-scale sample population, the study relied on a medium that is extensively used by young people in Taiwan: the Internet.

This chapter explains the methodology of this web-based survey, including a description of the features of the Internet-assisted survey method, the design of the questionnaire, and the administration of the survey. By collecting information from a larger-scale sample population, the third constituent study sought to address the following research questions (also see Table 4.1).

- 4.2.1 How do people perceive climate change and what is the level of public scientific knowledge of climate change in Taiwan?
- 4.2.2 Will a better understanding of climate science enhance people's willingness to change their behaviors and to endorse more stringent climate policies?

Subsection 4.6.2 discusses advantages and disadvantages of an Internet-assisted survey method and compares this approach to other survey methods. Subsection 4.6.3 describes the administration processes of this survey study. Subsection 4.6.4 explains the sampling issues that arise in the use of online surveys and introduces the sampling technique. Subsection 4.6.5 describes the various components of the questionnaire including question and format construction. Subsection 4.6.6 explains the method of data analysis. Subsection 4.6.7 concludes this section.

## 4.6.2 Internet-assisted Survey

### *Comparison of Survey Method*

There are four primary survey methods that differ in accordance with their modes of data collection: face-to-face, telephone, mail, and online.<sup>63</sup> Face-to-face and telephone interviews are administered by interviewers—trained interviewers ask respondents survey questions personally or via telephone and enter their responses into a database. In contrast, mail and online surveys are self-administered by interviewees. Survey questions are displayed in a paper format sent via mail or in an electronic format distributed via electronic mail (e-mail) or over the Internet, and respondents then submit their responses through the designed modes.

Table 4.7 compares the advantages and disadvantages of these four survey methods (Sue & Ritter, 2007; Fowler, 2009). Some of the key considerations include research feasibility (e.g., cost, required staff, access to samples, required time to prepare), research reliability (e.g., response rate, interviewer bias), and research design (e.g., geographic reach, sensitive topic, complex and contingent question). Each method has strengths and weaknesses and selection of a particular method depends on the requirements and restrictions of the particular project. An online survey may encounter problems of coverage bias, sample representativeness, and unidentified respondents, but

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<sup>63</sup> Online surveys include two common ways of data collection: e-mail surveys and web-based surveys. With e-mail practices, the prospective respondent receives an e-mail with a survey attached to it and sends a return e-mail back with the completed survey attached to or included with it. The researchers distribute and collect data fully through e-mail, but they need to manually transfer the raw data into a database. In contrast, with web-based surveys, the potential participant can receive an invitation e-mail or a pop-up message from other web sites containing a link to the survey website where he/she will find the survey instrument. The participant then completes and submits the survey online. The researchers collect data online with no need for manual data entry.

it has benefits of reduced time, lower cost, direct data entry, flexibility in format and wide geographic reach (Sue & Ritter, 2007; Fowler, 2009).

A number of studies have discussed the pros and cons of online data collection (Sax, et al., 2003; Granello & Wheaton, 2004; Van Selm & Jankowski, 2006; Lefever et al., 2007). Granello and Wheaton (2004) suggest that the benefits of online surveys are not fully apparent unless the limitations are addressed first. Weighing the benefits of this technique against the limitations imposed by this doctoral research (limited budget and staff), the decision was made to employ the web-based method.

**Table 4.7** Comparison of Advantages and Disadvantages of Different Survey Methods

Survey Type	Advantages	Disadvantages
<b>Face-to-face interview</b>	<ul style="list-style-type: none"> <li>• Good response rates</li> <li>• Can ask complex questions</li> <li>• Long interviews tolerated</li> <li>• Enlisting better cooperation</li> <li>• Can observe respondents</li> </ul>	<ul style="list-style-type: none"> <li>• Limited geographic reach</li> <li>• Time-consuming</li> <li>• Expensive</li> <li>• Interviewer bias</li> <li>• Sensitive topics difficult to explore</li> <li>• Requiring trained interviewer</li> </ul>
<b>Telephone</b>	<ul style="list-style-type: none"> <li>• Limited coverage bias</li> <li>• Speedy responses</li> <li>• Can ask complex questions</li> <li>• Wide geographic reach</li> <li>• Requiring fewer staff than face-to-face interview</li> </ul>	<ul style="list-style-type: none"> <li>• Confusion with sales calls</li> <li>• Intrusive</li> <li>• Call screening</li> <li>• No visual support</li> <li>• Sensitive topics difficult to explore</li> <li>• Requiring correct phone numbers</li> </ul>
<b>Mail</b>	<ul style="list-style-type: none"> <li>• Low cost</li> <li>• Wide geographic reach</li> <li>• No interviewer bias</li> <li>• Anonymity allows sensitive questions</li> <li>• Sufficient time for thoughtful answers</li> <li>• Requiring minimal staff</li> </ul>	<ul style="list-style-type: none"> <li>• Low response rate</li> <li>• Lengthy response period</li> <li>• Contingency questions not effective</li> <li>• Do not know who is responding to the survey</li> <li>• Difficult to enlisting cooperation</li> <li>• Requiring correct mailing addresses</li> </ul>
<b>Online</b>	<ul style="list-style-type: none"> <li>• Low cost</li> <li>• Fast</li> <li>• Efficient</li> <li>• Contingency questions effective</li> <li>• Direct data entry</li> <li>• Wide geographic reach</li> <li>• Sufficient time for thoughtful answers</li> </ul>	<ul style="list-style-type: none"> <li>• Coverage bias: limited to internet users</li> <li>• Problem of sample representativeness</li> <li>• Reliance on software</li> <li>• Do not know who is responding to the survey</li> <li>• Difficult to enlisting cooperation</li> <li>• Low response rate</li> <li>• Requiring correct email addresses</li> </ul>

Source: Sue & Ritter (2007); Fowler (2009)

*Overcoming Coverage Bias – Widespread Internet Usage*

Computer technology has improved and currently available systems facilitate survey research in a variety of ways, such as using statistical software for data analysis and assisting telephone interviews with data collection (Babbie, 1990; Fowler, 2009). The proliferation and rapid growth of the World Wide Web has taken the computer-assisted survey method to the next level—an “all-in-one” survey technique with multiple functions: data collection, data entry, and analysis. The technology makes the online survey an appealing research method.

Internet users in each geographical region have increased since 2000 with an average growth rate of 362.3% (Table 4.8). These Internet users comprised 24.7% of the world’s population in 2009 (Internet World Stats, 2009a). The Internet tends to be more commonly used in North American. Although Latin America and Asia have very high Internet user populations (52.7% of global Internet users), an overwhelming majority of the population does not use the Internet (penetration rates are less than 20%).

**Table 4.8** Internet Usage in Users and Penetration in Regions in 2009

<b>Region/Country</b>	<b>Internet Users</b>	<b>Penetration Rate (% population)</b>	<b>Growth Rate (Users 2000-2009)</b>
<b>World Total</b>	<b>1,668,870,408</b>	<b>24.7%</b>	<b>362.3%</b>
North America	251,735,500	73.9%	132.9%
Europe	402,380,474	50.1%	282.9%
Oceania/Australia	20,838,019	60.1%	173.4%
Latin American	175,834,439	30.0%	873.1%
Middle East	47,964,146	23.7%	1360.2%
Asia	704,213,930	18.5%	516.1%
Africa	65,903,900	6.7%	1359.9%

Source: Internet World Stats (2009a)

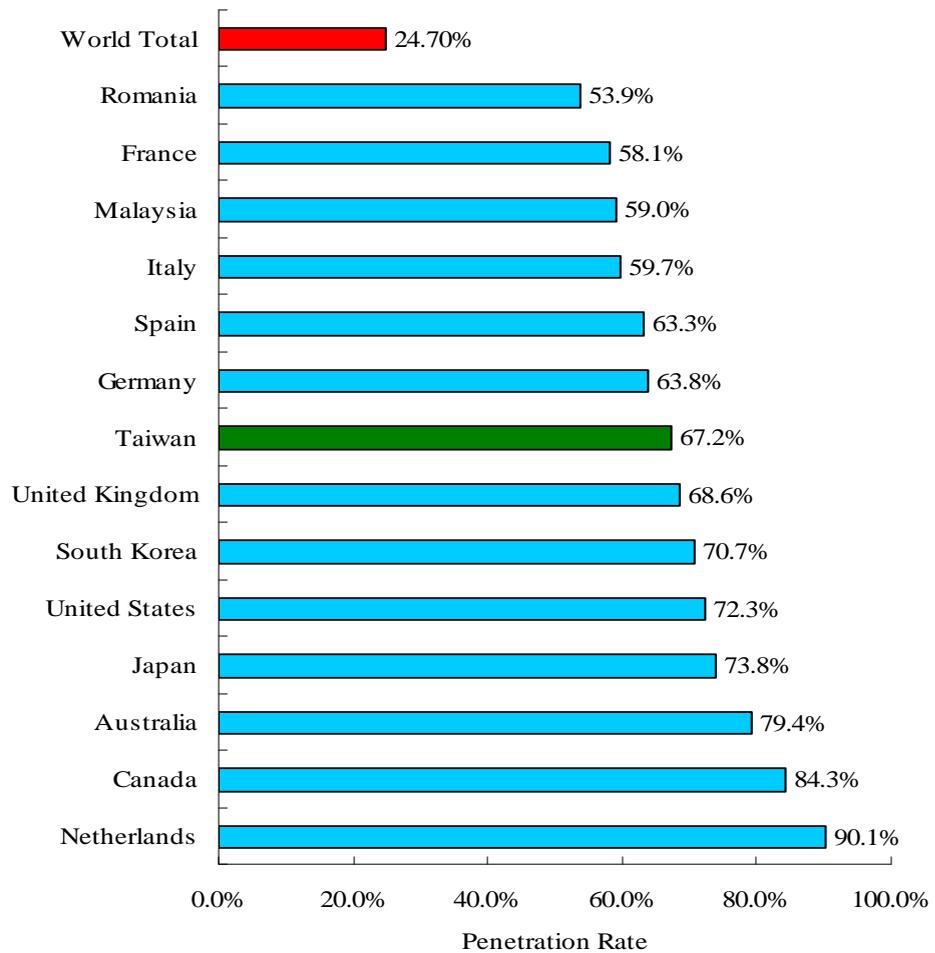
Taiwan, the study area in this doctoral research, was one of the countries with a widespread Internet environment (Table 4.9) and its penetration rate (67.2%) ranks 23rd in the world (Internet World Stats, 2009b). Compared to countries that have populations above 15 million and penetration rates above 50%, Taiwan was in eighth place (Figure 4.3). According to the Taiwan Network Information Center (TWNIC), the Internet penetration rate reached 71.0% of the population in the age category above 12 years of age in 2009 (TWNIC, 2009). Among various age groups, the group of youth (ages between 15 and 24 years old), the sample population, comprises a group of relatively high Internet users (Figure 4.4).

**Table 4.9** World Ranking of Internet Penetration in Selected Countries\*

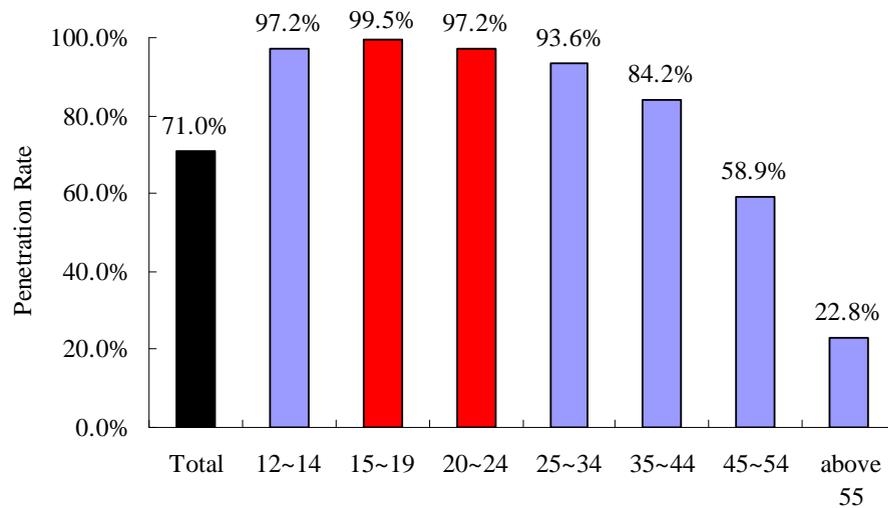
Rank	Country	Penetration Rate (% population)	Internet Users	Population
2	Netherlands	90.1%	15,000,000	16,645,313
6	Canada	84.3%	28,000,000	33,212,696
8	Australia	79.4%	16,355,388	20,600,856
11	Japan	73.8%	94,000,000	127,288,419
13	United States	72.3%	220,141,969	303,824,646
16	South Korea	70.7%	34,820,000	49,232,844
22	United Kingdom	68.6%	41,817,847	60,943,916
<b>23</b>	<b>Taiwan</b>	<b>67.2%</b>	<b>15,400,000</b>	<b>22,920,946</b>
26	Germany	63.8%	52,533,914	82,369,548
29	Spain	63.3%	25,623,329	40,491,051
32	Italy	59.7%	34,708,144	58,145,321
34	Malaysia	59.0%	14,904,000	25,274,133
36	France	58.1%	36,153,327	62,177,676
41	Romania	53.9%	12,000,000	22,246,862
	<b>World Total</b>	<b>24.70%</b>	<b>1,668,870,408</b>	<b>6,767,805,208</b>

Source: Source: Internet World Stats (2009b)

\* These countries were selected because their population exceeded 15 million people, which was comparable to the case of Taiwan.



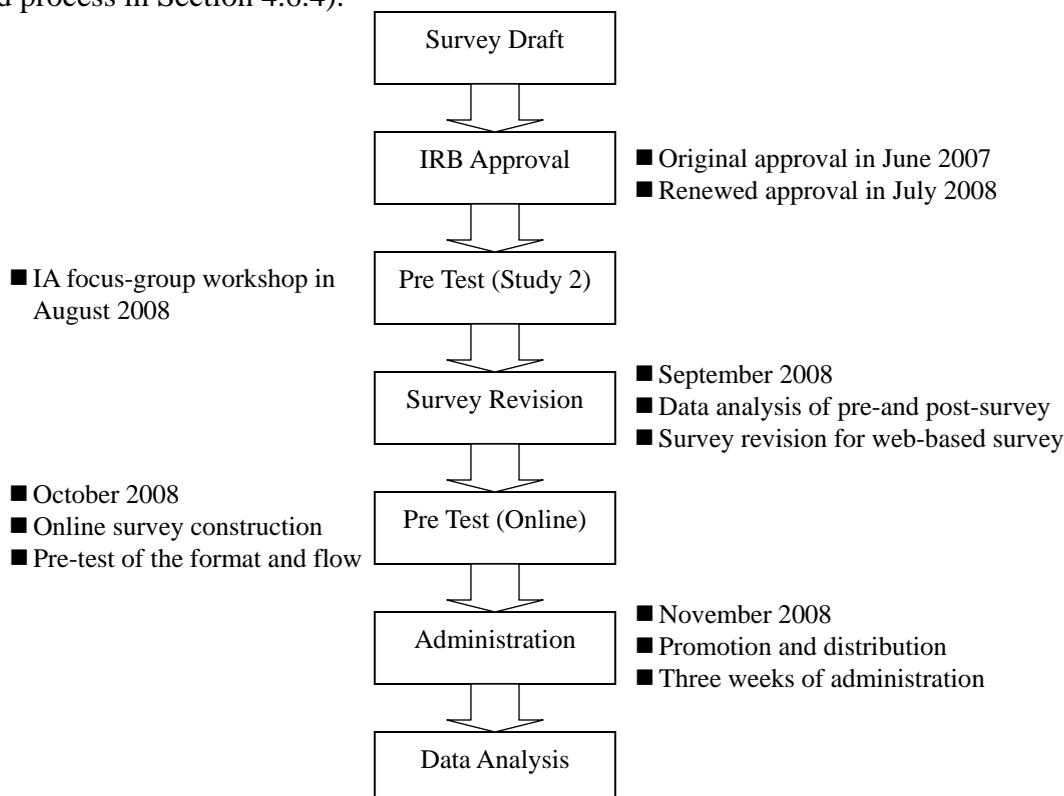
**Figure 4.3** Internet penetrations in selected countries (Internet World Stats, 2009b).



**Figure 4.4** Internet penetrations of different age groups in Taiwan (TWNIC, 2009).

### 4.6.3 Administration

Figure 4.5 highlights the complete execution process of this web-based survey. The survey in Study 2 was constituted in part as a pilot test procedure for the online survey used in Study 3. Experience with this survey helped to improve the length and the quality of the online survey questionnaire. The revised instrument was constructed on a web-survey host called *SurveyMonkey*<sup>64</sup> (see the completed instrument in Appendix B). The flow and format of the survey was pretested for one week. The finalized survey was then released for a period of three weeks in November 2008 (see the sampling technique and process in Section 4.6.4).



**Figure 4.5** The execution process and the schedule for the web-based survey study from preparation, pre-test, revision, administration, and analysis.

<sup>64</sup> SurveyMonkey is a commercial web-based survey host that offers a wide range of services, such as providing survey templates and various question types, supporting survey distribution and data collection, computing basic statistics, and exporting data to Excel files.

#### 4.6.4 Sampling

Most of the limitations of online-data collection (e.g., unidentified samples, low response rate, randomness and representativeness of samples) are associated with the sampling process. The first concern about conducting online surveys is dishonest respondents who do not enter honest answers. However, this weakness is a feature of paper-and-pencil surveys as well (Lefever et al., 2007). Thus, in an effort to avoid intentionally deceitful responses, this study designed an extra barrier that required potential participants to enter an access code that could only be acquired in the e-mail invitation.

A second concern is the potential for lower response rates from online surveys (Granello & Wheaton, 2004). However, unless researchers have access to information on the total number of prospective respondents within a specific sample population (e.g., e-mail lists, newsgroups), it is difficult to calculate response rates. Sax et al. (2003) found from a national survey of college students that web surveys have lower response rates than paper surveys. The result also indicated that a few factors that contributed to the low response rates included survey length, infrequent use of campus e-mail addresses, concern about privacy, and gender (i.e., women responded at a higher rate than did men).

Finally, Van Selm & Jankowski (2006) argue that it is problematic to achieve a random sample of Internet users because of the difficulty of obtaining e-mail lists of potential respondents and the variation in e-mail address construction. Even if a sample list is acquired from a newsgroup, these people are likely to be interested in specific topics. They thus suggested that online surveys work better for studies using non-probability samples, but they also advise that researchers need to strive for an acceptable level of randomness and representativeness to develop meaningful samples.

Conventional probability sampling methods have dominated survey research. This sampling method involves the random selection concept which means the selected sample group can represent the population. Non-probability sampling methods, on the other hand, have been used alternatively in limited budget circumstances and when a precise representativeness of the population is not necessary (Babbie, 1990). While government agencies and academic organizations heavily emphasize the use of probability sampling techniques, private political polling groups and market-research organizations rely on non-probability sampling methods (Fowler, 2009). Since the focus of this doctoral research was not a large-scale quantitative study for a general population, it was considered that a precise random sample would not be necessary.

This study employed two common techniques for non-probability sampling in online surveys: snowball sampling and convenience sampling. The snowball-sampling method first identifies one potential participant who meets the sample criteria (i.e., an enrolled university student) and asks the participant to refer someone else for the survey by forwarding around the e-mail invitation which included a link that directed prospective respondents to the survey. Similar to the approach used to recruit participants for the IA focus-group workshop, information about the study was released to several key Taiwanese youth organizations and spread among their member networks. To increase the number of respondents, the supplementary convenience sampling method was also used. In this case, the survey-invitation message containing the link to the survey was posted to several popular online community bulletin boards and discussion forums. The invitation briefly introduced this academic study and led the interested university students to the survey site.

Two disadvantages of these two sampling techniques can be identified. Since no direct incentive was provided, participation was completely voluntary. Potential participants self-selected into the study and may not be representative of the general population. In addition, because of the nature of the investigation, the respondents likely tended to comprise a group of individuals interested in the survey topic (Sue & Ritter, 2007). It merits observing, however, that the study may have benefitted by recruiting respondents with a higher willingness to participate in the survey. It is therefore necessary to apply special care when interpreting the results from the inference analysis. Furthermore, the current procedure for estimating the required number of respondents is based on the particular probability sampling method. There are no formulas for statistical inference when using a non-probability sampling method (Sue & Ritter, 2007). This study therefore sought to recruit as many respondents as feasible in a three-week period.

#### **4.6.5 Questionnaire Design**

##### *Revision of the Instrument*

The online survey instrument was modified and refined based on the results of the pre- and post-survey that had been carried out in summer of 2008 (see the completed instrument design in Section 4.5.5). The structures of these two surveys were the same with four sections, but the online version was shortened to a total of 40 items (see the completed instrument in Appendix B). To keep the completion time to approximately 10 minutes (so that the respondents did not lose patience), several questions deemed to be of secondary importance were eliminated.

First, Section I *General Concern* was shortened to twelve items. Questions regarding problem recognition, blame, and responsibility for climate change, economic

tradeoffs, and political priority were retained in the instrument. One dimension with two items was included to explore the respondents' trust in scientists. The Personal Relevancy Index, a composite Likert-scale of three items, was used to measure how the respondents evaluate the relationship between themselves and the issue of climate change in terms of causes, impacts, and actions. The phrasing of the third item (personal actions) was revised because the original wording had double-barreled concepts that were inconsistent with the Index on the basis of results from the pre-test survey.<sup>65</sup>

- *The original wording:* The problem of global climate change is so overwhelming that it is really beyond the control of a young person such as me.
- *The revised wording:* There is still something a young person such as me can do to contribute to resolve the problem of global climate change.

Second, to shorten the length of the survey instrument and to reduce the complexity of the original design in the second section, the online version selected twelve dichotomous questions to assess respondents' scientific understanding of climate change. The respondents were asked to answer whether these scientific statements were correct. Three items were designed for each variable: causes, adverse impacts, and mitigation policies. One item was intended to test knowledge pertaining to the scientific basis of the greenhouse effect. The remaining two items tested the knowledge of respondents in the policy-science dimension (Table 4.10).

This online survey eliminated two original variables (i.e., scientific observation and future protection) because the pre-test result found a low level of knowledge on those

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<sup>65</sup> Double-barreled concepts refer to inconsistent ideas in the same statement, which may cause respondents to become confused and misguided. For example, the respondents may disagree with the idea that global climate change is an overwhelming problem, but they may agree with the idea that the ability of a young person to effect change is limited.

items. To prevent respondents from dropping out due to frustration with difficult questions, twelve of the questions were purposely designed to be relatively easy. Of these items, six were quite straightforward and six were more modest questions based on the outcome of the pre- and post-survey. In addition, three statements are reverse-worded (Items 3, 6, and 10). The ozone layer-depletion item (Item 3) was intentionally designed to assess the common tendency to confound the separable problem of ozone depletion with global climate change. The remaining two questions were reverse-worded to prevent response sets (i.e., some respondents may tend to answer questions in a certain direction).

In the third section, the dimension of government commitment remained unchanged. The number of items in the two sets of questions (i.e., personal behaviors and the policy-preferences dimension) was reduced to three and five items respectively. In addition, the question regarding responsibility among various societal sectors was revised and moved from the first section to the third section. This revision tried to make the question focus more on the distribution of responsibility between specific producers and consumers.

- *The original wording:* Select from the following list the three entities that you think have primary responsibility for resolving global climate change?

Choices: Environmental groups; Every citizen; Industries; Media; National government; Scientists; No specific entity; Others.

- *The revised wording:* Which of the following groups in Taiwan bear primary responsibility for reducing their greenhouse gas emissions?

Choices: Industrial sector; Household/consumer sector; Both are equally responsible; Do not know.

Finally, the supplementary dimension of media experience was eliminated in the fourth section. A question regarding the location of each respondent's hometown was

added to understand the distribution of their respective backgrounds. The other four items soliciting demographic information (i.e., age, gender, academic majors, and educational status) remained in the revised survey.

**Table 4.10** Items of Scientific Knowledge and Variable in the Online Survey

Scientific Statement***	Variable	E/M**
1. The greenhouse effect is due to the reabsorption of outgoing infrared radiation by atmospheric greenhouse gasses, such as carbon dioxide.	G.E.	M
2. Industrial manufacturers emitting greenhouse gases during the production process contributes to global climate change.	Cause	E
3. Ozone layer depletion contributes to global climate change.*	Cause	M
4. Deforestation contributes to global climate change.	Cause	E
5. Increasing average global air and ocean temperatures are a potential consequence of global climate change.	Impact	E
6. Global climate change has no effect on the change in precipitation volume (i.e., increasing flood and drought, water resource shortage).*	Impact	M
7. Global average sea-level rise due to the melting glaciers and ice cap in mountain and polar region is a potential consequence of global climate change.	Impact	E
8. People using public transportation could likely moderate the effects of global climate change.	Mitigation	E
9. Industries implementing carbon capture and storage technology (i.e., storing carbon dioxide underground or in the oceans) could likely moderate the effects of global climate change.	Mitigation	M
10. Power plants using sources of renewable energy instead of fossil fuels like oil and coal to generate electricity could likely intensify the effects of global climate change.*	Mitigation	E
11. The main purpose of the Kyoto Protocol is to reduce carbon dioxide emissions in the industrialized countries.	Policy	M
12. Taiwan's carbon dioxide emission per capita (per person) is above the world's average.	Policy	M

\* indicates reversed-worded statement (Item 3, 6, 10).

\*\* E refers to easy items and M refers to modest items

\*\*\* The question was phrased as "Please indicate whether each of the following statements is correct. Do not worry if you do not know the answer as this is not a test."

### Survey Format

Because *SurveyMonkey* supports any language, the survey was written in Chinese, the respondents' native language. The link in the invitation directed potential participants to the welcome page of the survey which briefly described the objectives of the survey and its criteria with respect to eligibility to participate: an enrolled university student above 18 years old. The presentation of this information was then followed by a consent page with detailed instructions of the rights of research subjects and the contact information of the project investigator. By selecting the "I consent" option, the respondents officially started the survey. This process intended to ensure respondents' agreement to participate.

To provide a respondent-friendly online survey, the questionnaire used a multipage format that placed each question on its own page with navigation signs (previous and next buttons). The respondents could go back to previous questions to review or change their responses. In addition, a progress bar assisted respondents in completing the survey by indicating the percentage of the overall survey that remained to be completed. Moreover, various types of question formats were used, including multiple-choice/single-answer questions, multiple-choice/multiple-answers questions, Likert-type rating scales, and drop-down menu questions.

One contingent question was designed. On the one hand, a respondent who selected "Yes" in Q.16 would continue filling in his/her survey on Q.17 and then skip to Q.19. On the other hand, a respondent who selected "No" in Q.16 would jump to Q.18 directly and then continue to Q.19. Most importantly, to avoid non-response items and to ensure the quality of the data, all questions were designed to require answers—a respondent was not allowed to proceed to the next question without entering an answer.

#### **4.6.6 Data Analysis**

Similar to Study 2, the quantitative data in this web-based survey was mainly presented in two ways: a direct value or score of the item and a frequency (i.e., the percentage of responses in certain options). Because of a larger sample size, several statistical analyses could be administered. First, item analysis was carried out to ensure the internal validation of the three composite Likert scales in this survey (i.e., personal relevancy, behavioral intentions, and policy preferences).

Second, one-way univariate analyses of variance (ANOVA) were conducted to investigate the effect of two demographic variables (i.e., gender and academic majors) on dependent variables (i.e., general concern, trust in scientists, belief in human force, personal relevancy, scientific knowledge, personal behaviors, and policy preferences). Finally, Pearson correlation analysis was conducted to determine the degree of the linear relationships between two variables.

#### **4.6.7 Concluding Remarks**

The increased use of the Internet makes online data collection an appealing method with several advantages—low cost, ease of data entry, efficient, flexible format, and so forth. Considering benefits and limitations, this constituent study therefore used a web-based method. This study employed two techniques for non-probability sampling in online surveys: snowball sampling and convenience sampling. An invitation message that was released via e-mail or via the Internet directed potential participants to the survey site. The instrument was modified and shortened to 40 questions from the lengthy one used in the pre- and post-study. Nonetheless, the structure and variables remained the same.

## 4.7 Summary

Interdisciplinary coordination and collective sustainable actions from all facets of society will be important to addressing the problem of global climate change. The key research question in this inquiry is whether public understanding of climate science is a necessary prerequisite for effective policy making. Thus, this doctoral research focuses on identifying the integration of the science and the public in the policy-making process. The investigation comprises three interrelated constituent studies and adopts a mixed-methods methodology with both quantitative and qualitative elements. This chapter describes the reasons for selecting university students as the study population and then introduces the research method used in each study in detail.

This research selected the subpopulation of youth as the study population because the involvement of youth in sustainable issues is significant in terms of representing a wide range of societal perspectives and bringing unique and intergenerational viewpoints to the implementation of sustainable development. A complex issue like global climate change especially requires the active participation of youth in formulating climate policies. In addition, this case study specifically focuses on Taiwanese university students because participation in higher education is widespread in Taiwan.

Study 1 employed IA focus groups to qualitatively measure Taiwanese university students' perspectives about climate change and to assess the effectiveness of a participatory exercise in enhancing scientific understanding and in formulating climate policies. The modified IA focus-group workshop consisted of three sessions: participants' spontaneous expressions, expert presentations, and synthesis of informed participants' conclusions about Taiwanese climate policies.

Study 2 was a pre- and post-comparative survey conducted in the IA focus-groups to learn how the expert-integrated focus-group workshop influenced the participants' understanding of the issue of global climate change. This study used a standardized survey to quantitatively measure Taiwanese university students' overall concern (general attitudes, scientific understanding) and individual responses (behavioral intention and policy preferences) toward the issue of global climate change. The multiple-item survey instrument was constructed with a structure consisting of several sections. As discussed in the chapter, several types of questions were designed.

Study 3 employed a web-based survey because of the various advantages of the online-survey method. Modified from the survey instrument used in Study 2, the instrument of this web-based study was more concise. This study used two techniques for non-probability sampling in online surveys: snowball sampling and convenience sampling. An invitation message that was released via e-mail or via the web directed potential participants to the survey site. This study sought to recruit as many respondents as feasible in a three-week period in November 2008.

In conclusion, this research anticipates that these three constituent studies in combination is a satisfactory approach to effectively address the primary research question (i.e., identifying the relationship between scientific understanding and policymaking), but also can explore the interactive relationship between experts and lay people through an experimental participatory exercise. By incorporating various social science research methods, both quantitative and qualitative information was acquired, that can facilitate data interpretation in the following chapter which discusses the results and analysis generated by this methodology.

## **CHAPTER 5**

### **RESULT AND ANALYSIS**

#### **5.1 Overview**

Under the purview of modern democratic governance, it is essential to incorporate science and the public in the policy-making process for complex environmental problems. It is of particular interest to explore how a person develops his or her attitudes, scientific understanding, and behavioral intentions from a socio-psychological perspective and to investigate how a scientifically literate citizen influences his or her personal behaviors and policy support. As described in Chapter 4, this interdisciplinary doctoral research comprises three interrelated constituent studies to jointly address some related inquiries regarding the public understanding of climate science (see Section 4.2).

Targeting an important subpopulation (i.e., youth), the entire investigation was conducted in Taiwan in the summer and fall of 2008 with 303 young adults involved. Due to the design of three interrelated studies and research questions, this chapter aims to present the results of this work separately and then to quantitatively and qualitatively analyze the corroborated findings in depth. Section 5.2 describes the research results of each study (i.e., an IA focus-group workshop, a pre- and post-survey, and a web-based survey). Section 5.3 combines the results of the three studies and provides an integrated analysis of the different factors underlying the public understanding of climate science (i.e., attitudes, knowledge, and behavioral intentions) and of the relationships among these elements. It also compares the findings with preceding sociological studies. The last section summarizes key findings of this research.

## 5.2 Research Results

### 5.2.1 Introduction

As introduced in Chapter 4, this doctoral research aims to explore whether public understanding of climate science is a necessary prerequisite for effective policy making with three constituent studies (i.e., an IA focus-group workshop, a pre- and post-survey, and a web-based survey). Adopting a mixed methodology, the research is able to examine the various constituent elements of the public understanding of climate science and also to observe the dynamic relationship between scientific experts and citizens from the standpoint of experimental participatory practice. These three studies collectively expect to achieve the following research objectives:

- To examine the concerns of Taiwanese youth about global climate change in terms of their attitudes, scientific knowledge, and behavioral intentions.
- To investigate the interrelationships among these three elements (i.e., attitudes, scientific knowledge, and behavioral intentions).
- To assess the effectiveness of an experimental participatory exercise (i.e., the IA focus groups) in enhancing individual scientific understanding and engagement in policy making.

This section primarily summarizes the key research findings of each of the constituent studies in three subsections. In-depth comparison and cross-examination will be analyzed in Section 5.3. Subsection 5.2.2 describes the result observed in the IA focus-group discussions with highlights of some in-depth dialogues among the participants. Subsection 5.2.3 presents the quantitative results of the comparative surveys collected in the IA focus-group workshop. Subsection 5.2.4 illustrates the results of the web-based survey to measure Taiwanese young adults' attitudes about and understanding of climate change. Subsection 5.2.5 concludes with a few remarks.

### 5.2.2 Study 1: IA Focus-Group Workshop

#### *Summary of the Approach*

To understand Taiwanese university students' perspectives about the issue of global climate change and to assess the effectiveness of a participatory exercise in enhancing scientific understanding and in formulating climate policies, a modified one-day IA focus-group workshop was organized in Taipei in the summer of 2008. The young adults who voluntarily registered for the workshop were expected to have a relatively high level of personal concern about global climate change. The participants were divided into two groups for more efficient discussions (Group A and Group B). One moderator and one assistant moderator were assigned to each group to facilitate the discussion.

The workshop consisted of three sessions: 1) the participants shared their initial impressions, 2) the experts presented current research findings (physical science and policy science of climate change), and 3) the participants engaged in discussion with the aim of reaching a consensus view. Several general issues were discussed in both groups (i.e., anthropogenic causes, the responsibility of industrialized and developing countries, the responsibility of industries and the public in Taiwan, the ratification of the Kyoto Protocol in Taiwan).

Each focus group then discussed one domestic climate policy (mitigation strategy) and tried to reach a group consensus—whether to support the policy or not. Group A discussed a voluntary-based governmental initiative “Energy Conservation and Carbon Reduction Program.” Group B discussed a mandatory policy “Greenhouse Gas Reduction Bill (Draft).” Since the entire process was video-recorded and transcribed to written documents, some interesting observations in the discussion were able to be extracted and

the selected dialogues are presented in the following (also see Section 4.4 for the detailed method).

### *Characteristics of Participants*

A total of 25 Taiwanese young adults registered to participate in the designed IA focus-group workshop before the application deadline, but only 18 of them ultimately came on the designated day (n=18). Thirteen of these participants (aged between 19 and 32 years) were currently enrolled university students (eight undergraduates and five graduates), and five were young professionals. In addition, the focus groups included 11 male and 7 female participants. The respondents were mixed equally and divided into two smaller groups according to gender and academic background.

### *Motivations of Participation*

The participants were required to describe the motivation behind their participation in an open-ended question when they registered for the event, and they were also instructed to share their motivations with group members when they introduced themselves in the first session. Even though all of the respondents were interested in climate change to some degree, their personal motivations for participating in a day-long workshop varied.<sup>66</sup>

The results show that most of the participants admitted that they did not understand the issue and saw the workshop as an opportunity to acquire knowledge. Only a handful of the participants did so because they wanted to actively contribute their own personal viewpoints. Hence, a search for external information was deemed to be the

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<sup>66</sup> This subsection primarily presents qualitative dialogues. It is difficult to quantify the participants' responses in a group discussion because once a point is mentioned by a group member; it is unlikely another member would repeat the same point. For the precise quantitative measurement in IA focus groups, see Subsection 5.2.3.

primary motivation, which is different from Darier et al.'s (1999a) findings—European citizens participate in citizen panels for two reasons according to these authors (i.e., it leads to better policy decisions and implementation; it is good to exchange diverse perspectives).

### General Perceptions of Global Climate Change

The participants were asked in the first session to describe their personal impressions of global climate change, to discuss the extent to which they recognized it as a problem, and to identify its causes and consequences. From the participants' spontaneous expressions about global climate change prior to the expert treatment, it is clear that they had prior knowledge of the issue despite variations in their respective levels of scientific understanding of climate change. For example, a couple of the participants were even able to explain the science of the greenhouse effect and the *El Niño* phenomenon.

Several of the participants correctly described global climate change as changes or anomalies in meteorological patterns over a long period of time, such as precipitation and temperature variability. A number of the respondents in Group B had an interesting discussion about a controversial issue—whether global climate change is a result of natural fluctuations. The dialogue was as follows:

Global climate change breaks the original natural climate cycle. For example, ice melts because the temperature is above, rather below, 0°C in winter. It also includes the ozone hole, the *El Niño* phenomenon, and the ultraviolet exposure index in the weather forecast. The greenhouse effect is a normal natural phenomenon. The earth would freeze without it. Global warming is abnormal because industries emit greenhouse gasses which accelerate the greenhouse effect. (Youth no. 2, Group B, Session 1)

Weather is short term, but the climate is long term. There is supposedly a climate cycle—it is hot when it should be; it is cold when it should be; it rains when it should. Yes, the average temperature in this century is slowly increasing, but if we examine it from a long-term perspective, it may be just a natural fluctuation phenomenon like the stock index.

(Youth no. 6, Group B, Session 1)

Most scholars think that global warming is induced by human activities most likely with greenhouse gas emissions like methane, carbon monoxide, and carbon dioxide.

(Youth no. 9, Group B, Session 1)

Some scholars think that the global warming phenomenon is normal and periodic, but it is still a hypothesis. It is not very certain.

(Youth no. 25, Group B, Session 1)

Based on the above dialogue, it can be inferred that while some participants had an accurate understanding of climate change, some participants displayed a tendency to confuse ozone depletion with climate change and others mistakenly identified carbon monoxide as a greenhouse gas. A similar misunderstanding was also found in Group A.

### *Problem Recognition*

The participants were then asked to share whether they thought there was a climate change problem globally and in Taiwan. They were able to shed light on their understanding of the climate-related impacts at both a global and local level. In addition, it is interesting to find that the participants tended to cite their personal experiences or the information derived from the mass media as the reference when illustrating their opinions about the reality of global climate change.

- Global Level

The problem happens at a global scale, such as sea-level rise. An island country in the Pacific Ocean, Tuvalu, is almost flooded. It will also decrease the land area in Taiwan. (Youth no. 22, Group A, Session 1)

- Global Level

I believe that some animals will become extinct, such as king penguins and polar bears. (Youth no. 4, Group A, Session 1)

Many Europeans were killed in heat waves. (Youth no. 25, Group B, Session 1)

- Local Level

There will be some water shortage problems. Taiwan is small, and it is already difficult to reserve water. If climate change causes a lower amount of precipitation or intensive rainfalls, it is impossible for watershed to retain water resources. (Youth no. 4, Group A, Session 1)

Typhoons may bring heavy rainfalls. (Youth no. 13, Group B, Session 1)

It seems that there are more typhoons in fall now (i.e., October and November). (Youth no. 25, Group B, Session 1)

- Personal Experiences

My hometown is Penghu (an islet in southwest Taiwan). I have seen the coast since I was a kid. I have discovered that the coastline is retreating in recent years. (Youth no. 14, Group A, Session 1)

The ice cap in the Arctic area is melting. I once went to New Zealand during the 2001 summer break (winter there). One glacier was retreating dramatically compared with a picture taken a year before. I was so surprised when I saw the pictures. (Youth no. 23, Group B, Session 1)

Summer is getting longer and getting hotter. (Youth no. 6, Group B, Session 1)

- Mass Media Influence

I once saw a Discovery show reporting that the way of life has changed in the Netherlands because of the climate. (Youth no. 10, Group A, Session 1)

The girl in the Simpsons has an ice cream which melts fast because of the high temperature (an iconic plot in the documentary “*An Inconvenient Truth*”). (Youth no. 20, Group B, Session 1)

- Mass Media Influence

The escalator taken by Mr. Al Gore in “*An Inconvenient Truth*” was very impressive. It seems that the current temperature has way surpassed the earth’s historical records of temperature. So in addition to natural factors, there are definitely some anthropogenic forces existing.

(Youth no. 7, Group B, Session 1)

### Identification of Causes and Consequences

When asked to identify causes and consequences of global climate change, both groups were able to produce a comprehensive picture during the group discussion. This experience suggests that it is beneficial for scientific information to be exchanged through interactions among group members, but there is also a chance that incorrect information is transmitted. In addition to anthropogenic causes of climate change, a couple of the more knowledgeable participants mentioned natural factors, such as solar radiation and the *El Niño* phenomenon. Moreover, some underlying political and economic factors were mentioned:

One cause is lifestyle. When humans’ way of life was changed by the industrial revolution and capitalism, corporations and industries got stronger and more carbon dioxide was emitted. The traditional and simple lifestyle has been changed.

(Youth no. 10, Group A, Session 1)

Politically speaking, one cause is that industrialized countries give the economy priority to the environment. These countries throw the responsibility of pollution problems to developing countries for their own benefit.

(Youth no. 6, Group B, Session 1)

### Anthropogenic Contribution and Responsibility

After two briefings on the aspects of science and the politics of global climate change, the participants were guided to discuss several issues in detail, namely the anthropogenic forces and responsibility, the differentiated responsibility of GHG emission reduction,

and Taiwan's compliance with the Kyoto Protocol. Most of the participants recognized the dominant influences of human activities on the climate system and the high scientific confidence in the 2007 IPCC report presented by the experts. However, a few of them were hesitant because of concern about some possible unknown factors (i.e., there might be something humans do not know yet) and the limited information on hand (i.e., the expert presentation may have only provided a part of the scientific information).

In addition, an interesting perspective was revealed during the discussion—the participants tended to conceptually delink the corresponding relationship between anthropogenic contribution and responsibility. In other words, some participants argued that humans need to take actions and the responsibility to resolve the problem regardless of the debate over whether climate change is driven by human actions. This perception is different from the opinion in Western societies where sufficient scientific evidence of anthropogenic forces seems to be a key factor limiting action. The dialogue was as follows:

Based on the slides of the two experts, the atmospheric concentrations of carbon dioxide and methane have increased dramatically in 250 years. If this hypothesis is correct, it seems that global climate change is induced by humans. No matter what, humans need to do something. We need to be responsible for the environment we live in. If humans do not take responsibility, all of mankind will be affected.

(Youth no. 6, Group B, Session 3)

I think it [global climate change] is induced by human activities. However, even if it is not, there is no reason we can continue the current way of life. It is probably not a bad idea to address the problem from a precautionary aspect just like the expert mentioned. (Youth no. 23, Group B, Session 3)

I would not say it [global climate change] is directly caused by humans. Based on the current known reality and environmental advocacy it seems that humans primarily cause the problem, but there are certainly some unknown factors. I'm just wondering why we are discussing this issue. Even if it is not caused by humans, don't we need to have some responses?

(Youth no. 20, Group B, Session 3)

Humans surely need to take responsibility. It [global climate change] could be caused by humans or even by earthworms. Who causes the problem is not the point. The key point is that only humans can make efforts. Only humans can save the earth. We can not do nothing and leave it to nature. It is irresponsible. We still need to try our best.

(Youth no. 24, Group B, Session 3)

Human beings consider themselves as the most superior animal on the earth. We have ability to change. In addition, humans are likely impacted most among all species. Thus, we have the inevitable responsibility.

(Youth no. 20, Group B, Session 3)

The above discussion also shows that there is potential for the participants to accept the precautionary concept—to take mitigative actions despite scientific uncertainty. In addition, the participants tended to endorse an ethical environmental attitude—a moral feeling that humans should resolve the problem. Moreover, it is interesting to observe that one key justification behind this moral attitude is humans' sense of superiority. The participants displayed a strong belief that humans' exceptional intelligence and capability can resolve the problem.

#### *Common but Differentiated Responsibility*

Considering historical GHG emissions in the aggregate and in terms of per capita shares, the participants were instructed to discuss who (i.e., industrialized and developing countries) should bear primary responsibility for reducing GHG emissions. The results indicate that most of the participants supported the idea that all countries (both developing and industrialized countries) should take common responsibility to reduce GHG emissions and that the industrialized countries with high GHG emissions and better technological and financial capacity should take additional responsibility.

However, the respondents raised a number of questions about how to allocate each nation's responsibility and how to calculate each nation's emission allowance. The participants in Group B discussed two primary principles: *polluter pays* and *retroactive liability*. The first concept means that whoever pollutes should be held liable based on proportions—the more you pollute, the more you pay. Supplementing the first principle, the latter concept suggests that the historical GHG emissions of each country need to be taken into consideration—polluters should still be liable for past emissions. The following discussion highlights their argument.

Those who gain the most profit from industrial development should be responsible. Polluters should pay. Those with capacity and experience should also take responsibility. (Youth no. 24, Group B, Session 3)

However, the ones with the most profit are not necessarily the most polluting. Responsibility should be based on the quantity of emissions, not on the time span of emissions [who emits longer]. If we compare the emissions of the United States and China, we will find that even though the US is a developed country, its emissions are still a lot. China is a developing country, but its current emission is also a lot. It is impossible to permit China to pollute for 100 years given the fact that the US has polluted 100 years. (Youth no. 23, Group B, Session 3)

The experts said that carbon emissions from OECD countries comprise 80 percent of global emissions. So we can focus on these countries to do the reduction. Besides, even though China is willing to comply in the post-Kyoto period, they want to use a standard based on emissions per capita. Maybe we can measure the emission responsibility based on industries, not on nations. (Youth no. 7, Group B, Session 3)

Basically, the serious problem of climate change was caused by developed countries in the past. It is not fair to ask developing countries to bear the responsibility. It will kill their economic growth. If the responsibility standard is based on current emissions, it is not fair for developing countries. Developing countries need to develop industries to grow the economy. I think developing countries should have higher emission allowances, but not too high. (Youth no. 2, Group B, Session 3)

But if we are going to retrace historical emissions, when should we start? (Youth no. 6, Group B, Session 3)

In addition, interestingly, both groups discussed the problem of calculating the emissions of multinational corporations and their responsibility. Group A argued that determining GHG emissions should be based on the country in which a multinational company has its headquarters registered rather than where it carries out its manufacturing activities.

I think both developed and developing countries should take responsibility. Developed countries have benefited from past pollution. We need to consider the historical emissions of developed countries. I have a question. Should the emissions of multinational corporations be counted in developing countries (where the factory is) or in developed countries (where the business has its headquarters)?

(Youth no. 10, Group A, Session 3)

All countries are responsible. Developed countries should take more responsibility, but we also need to pay attention as some developing countries have emitted more than developed countries. Developed countries should provide technology support. As to multinational corporations, I think we should consider the location of the mother company—where the multinational company registers its headquarters. There was a Taiwanese company once thinking of replanting forests in China in exchange for carbon emission credits in Taiwan—pollution in Taiwan and reforestation in China. This fulfills the idea of carbon trading.

(Youth no. 21, Group A, Session 3)

### *Responsibility of Industries and the General Public in Taiwan*

It is notable that one of the experts highlighted the structure of CO<sub>2</sub> emissions by sectors in Taiwan during the second session. One key message was that Taiwanese industry contributes the majority of the country's CO<sub>2</sub> emissions (53.6%), which suggested that industries should be the primary target of blame. Interestingly, although the participants received this information, they did not directly point fingers at industry when asked to assess whether manufacturing companies or the general public should be held responsible for reducing CO<sub>2</sub> emissions. In contrast, they recognized the public's responsibility.

Group B concluded that both industries and the public should bear common responsibility. While actions should be taken on the part of each individual, large corporations that profit from industrial processes should take more responsibility. An interesting dialogue in Group B:

Ethically speaking, everyone should take responsibility, but the implementation would be probably more thorough if we regulate industries in policy. (Youth no. 6, Group B, Session 3)

We need to begin with some large corporations because of their enormous emissions. However, the relationship between politics and business is complicated. (Youth no. 23, Group B, Session 3)

Which sector (industry or the general public) in Taiwan should bear primary responsibility is related to the industrial structure. Dr. Lin presented that energy-intensive industries in Taiwan contribute to a low percentage of GDP. It is not impossible to adjust the industrial structure. The problem is not if we can't but if we do not want to. The government continues to provide subsidies (to industries) because they are politically influential to help the Government's rule. I think that both industries and the public should take responsibility, but maybe industry should bear more responsibility. (Youth no. 7, Group B, Session 3)

Everyone is responsible. If I need to choose one between industries and the general public to bear primary responsibility, I will choose industries. The emission reduced by us through energy savings for 10 years may be as well as equal to the emissions of a new factory. (Youth no. 2, Group B, Session 3)

In addition, while both groups emphasized the role of government in reducing Taiwan's CO<sub>2</sub> emissions, some interesting political issues were discussed specifically in Group A. The participants concluded that the government and industries are both responsible for high CO<sub>2</sub> emissions because the government has highly depended on energy-intensive industries to develop its economy. Moreover, some participants thought that public opinions are neglected because of the tight alliance between the government

and business. Furthermore, one participant recognized the lack of political power of the TEPA among government agencies.

The government is also responsible because it formulates and implements policies. The government should assist business to transform from high energy intensive industries. (Youth no. 4, Group A, Session 3)

The government should share a large portion of responsibility because the policy allows the construction of high polluting industries, such as steel plants. We have too many tax exemption strategies for high energy intensive industries. The government and industries are accomplices. Corporations can lobby in the policymaking process. We are liable because we elected such legislators and government officials. (Youth no. 21, Group A, Session 3)

I think everybody is responsible, but if I need to pick the priority, I will select industries and the government. The government is in charge with the direction of policies and information. It is difficult to distinguish the government and industries because they both have more political power and resources. (Youth no. 10, Group A, Session 3)

Policies are always controlled by a small group of people (i.e., the government and few corporations). I agree that both the government and industries are responsible. We don't even know how these policies are formulated. The opinions of the general public are often neglected. People should have their voice heard. (Youth no. 1, Group A, Session 3)

I think that the commissioner of the Environmental Protection Administration needs to be very powerful and famous. If so, he or she can confront large corporations with public support. (Youth no. 22, Group A, Session 3)

### Taiwan vs. the Kyoto Protocol

The participants had different opinions on whether Taiwan should ratify the Kyoto Protocol. One key concern was Taiwan's difficult diplomatic situation. One participant expressed that "the international society does not recognize us as a country and nobody invites us to sign the Kyoto Protocol." On the contrary, another participant argued that "if we ratify the Protocol, it will be beneficial to our national image and international status."

Nevertheless, 17 out of 18 participants tended to support the idea that Taiwan should reduce its GHG emissions. In addition, several of them were in favor of implementing mandatory policies on industries that could reduce GHG emissions more effectively, but they thought that there should be supplementary strategies (e.g., incentives).

Taiwan should implement mandatory policies to reduce GHG emissions. If we adopt voluntary strategies, it is difficult to regulate because every civil group has different opinions. It would be easier to implement a law.

(Youth no. 8, Group A, Session 3)

I think we should use mandatory methods on industry, but we also need to have good supplementary strategies to persuade industries—let them believe that they will not be harmed. For example, we could subsidize industries to develop green products. (Youth no. 14, Group A, Session 3)

### *Domestic Mitigation Policies in Taiwan*

In the final part of Session 3, two groups were instructed to discuss whether they supported the two ongoing domestic mitigation policies (see Session 3.5 for the detailed content). Group A was assigned to discuss a voluntary-based governmental initiative “Energy Conservation and Carbon Reduction Program.” The participants basically supported this program, but questioned the effectiveness and implementation difficulties of some strategies. Some points are extracted below:

There is no incentive provided when promoting this initiative. The program should indicate how these actions can benefit Taiwan and each individual.

(Youth no. 22, Group A, Session 3)

I think some actions are controversial. For example, the energy consumed to produce recycled papers may be more than the energy consumed to produce new papers.

(Youth no. 21, Group A, Session 3)

When encouraging people to ride a bicycle to commute, Taiwanese weather factors are not considered. There is no shower room to change cloths in companies for commuters.

(Youth no. 8, Group A, Session 3)

It will require some supplementary strategies to promote these ten actions (e.g., incentives). For example, if we increase electricity fees, people have incentives to save energy. People will recycle resources if they can get some money compensation. If we want to encourage people to take public transportation systems more, we should have more metro lines or increase the frequency of busses. (Youth no. 4, Group A, Session 3)

It encourages people to carry personal cups and chopsticks, but some restaurants or some conferences still provide disposable products, which may diminish people's willingness to comply. (Youth no 14, Group A, Session 3)

In addition, while discussing this program to target the general public in particular, the participants questioned the efficacy for reducing Taiwan's GHG emissions. An interesting discussion took place in Group A.

I am more worried that such policies may cover other more important and more worthy discussion parts because this part of CO<sub>2</sub> emissions only consists of 11.9% of the total CO<sub>2</sub> emissions in Taiwan. (Youth no. 10, Group A, Session 3)

Implementing this initiative is to misplace the resources. What the government should promote is the adjustment of the industrial structure. I support the content of this program, but I don't think this is a job for the government. It is more likely what school teachers should do. (Youth no. 21, Group A, Session 3)

This program should be done, but if considering priority, it is not the most important thing. In addition, it may mislead the general public that the problem would be solved as long as they take these actions. (Youth, 14, Group A, Session 3)

Group B discussed a mandatory cap-and-trade policy "Greenhouse Gas Reduction Bill (Draft)." Although the group reached a consensus to support this policy, they raised a number of issues worthy to discuss. First, one participant thought that it would be a little bit unfair if the cap did not consider historical emissions. A second participant suggested that the implementation should take a progressive path. A third participant was concerned

about whether this strategy would reduce GHG emissions effectively or just displace the problem. He argued that there should be a plan to reduce the cap (i.e., emission allowance).

There can be a strategy between a mother company and a branch company. One of them emits, and the other one reduces. They comply with the regulation superficially, but then these two companies do not lose anything. It is not fair and not beneficial for the reduction of total emissions.

(Youth no. 7, Group B, Session 3)

### Perception about the Mass Media

Interestingly, during the discussion some participants began to question the information delivered by the mass media. A discussion about the mass media took place in Group A.

The media keeps asking us to turn off the lights and plant trees. But the key problem is in industries. The media focuses on the effort of reducing carbon from the general public. The general public has barriers to get to know the issue, and that is why everybody tends to extract information from the media.

(Youth no. 10, Group A, Session 3)

The strange thing is the media asks us to eat vegetable. But how exactly can being a vegetarian help carbon reduction?

(Youth no. 14, Group A, Session 3)

The key point is food mileage. Take beef as an example. It consumes a lot of energy and carbon to import beef from New Zealand or Australia. That is why we are encouraged to eat local food products. But the media simplifies the problem to eating organic foods.

(Youth no. 21, Group A, Session 3)

### Other Observations

It was found that scientific experts indeed assist the participants. Even though some participants were fairly knowledgeable, they often cited information from the two invited experts to help themselves make an informed decision during their group discussion.

Furthermore, not only did the experts assist the participants by providing scientific information, some knowledgeable participants also helped to answer their fellow respondents' questions. Finally, comments from the participants also contributed to the quality of domestic climate policies. The participants raised a couple of new ideas such as retroactive liability and carbon labeling on products. They also provided some insightful perspectives on concerns and difficulties about compliance with the voluntary program on conserving energy and reducing carbon emissions.

#### Summary of Findings

Most of the participants expected to acquire information from the IA focus group. While the participants' level of scientific understanding of climate change varied, they managed to collectively identify causes and consequences during the group discussion. In addition, although most of the participants recognized human influences on the climate system, they also thought that humans needed to resolve the problem regardless of whether climate change is driven by human activities. Moreover, the participants supported the concept of the common but differentiated responsibilities. Furthermore, most of the respondents thought that Taiwan should reduce its GHG emissions and that industries, the government, and the public should bear the responsibility. Finally, both groups reached a consensus to support the two domestic climate policies.

### **5.2.3 Study 2: Pre- and Post-Survey**

#### Summary of Approach

To understand how the expert-integrated focus groups influenced the participants' comprehension of global climate change, a standardized quantitative multiple-item

survey was administered at the beginning and end of the IA focus-group workshop. The study collected data on participants' concern about climate change (i.e., attitudes, scientific knowledge, behavioral intentions, and policy preferences). In addition, comparison of the pre- and post-survey responses could be used to assess potential changes of the participants' overall level of understanding (also see Section 4.5 for the detailed method).

The survey was constructed with four sections and numerous dimensions (see Appendix A for the complete instrument). The first section "General Concern" comprises a number of variables (e.g., problem recognition, personal relevancy index). The second section "Scientific Knowledge" includes several questions to measure respondents' correct scientific understanding of the science, causes, consequences, and mitigation strategies associated with climate change. The third section "Individual Responses" aims to investigate respondents' views about a variety of mitigation strategies (e.g., willingness to change personal behaviors, mitigation policy preferences). The final section consists of questions regarding respondents' demographic information (e.g., age and gender).

Several formats were used in the survey (e.g., dichotomous, multiple choice, and Likert scale). This subsection highlights some key results of this survey. It is notable that the sample characteristics are the same with that of the IA focus group—a total of 18 respondents (with ages between 19 and 32 years), 11 male and 7 female respondents, and 13 university students and 5 young professionals.

#### *Familiarity with Terms and Policies*

The respondents (n=18) were asked to self-evaluate their level of familiarity with a variety of terms and policies on a 5-point Likert scale (a higher score indicates a higher

level of familiarity). The pretest survey found that the respondents were more familiar with the term “global warming” (rating average: 3.2 out of 5 points) than with “greenhouse effect” (3.1 points) and “global climate change” (2.9 points). They were less familiar with the Kyoto Protocol (2.3 points) and the Taiwanese Greenhouse Gas Reduction Bill (Draft) (1.4 points). The post-test survey demonstrated that the respondents expressed a higher level of familiarity with all five items after the IA focus groups.

#### Attitudes—Problem Recognition

When asked about their first impression of global climate change, the majority of the respondents referred to changes in seasonal variability (94%), sea level (78%), local temperatures (72%), and precipitation (67%). However, approximately half of them referred to “global climate change” as “stratospheric ozone depletion” and “ultraviolet light intensity.” In addition, a majority of the respondents thought that Taiwan had experienced a number of adverse conditions over the course of the past decade: hotter summers (94%), warmer winters (83%), longer droughts (61%), and stronger precipitation intensity (61%).

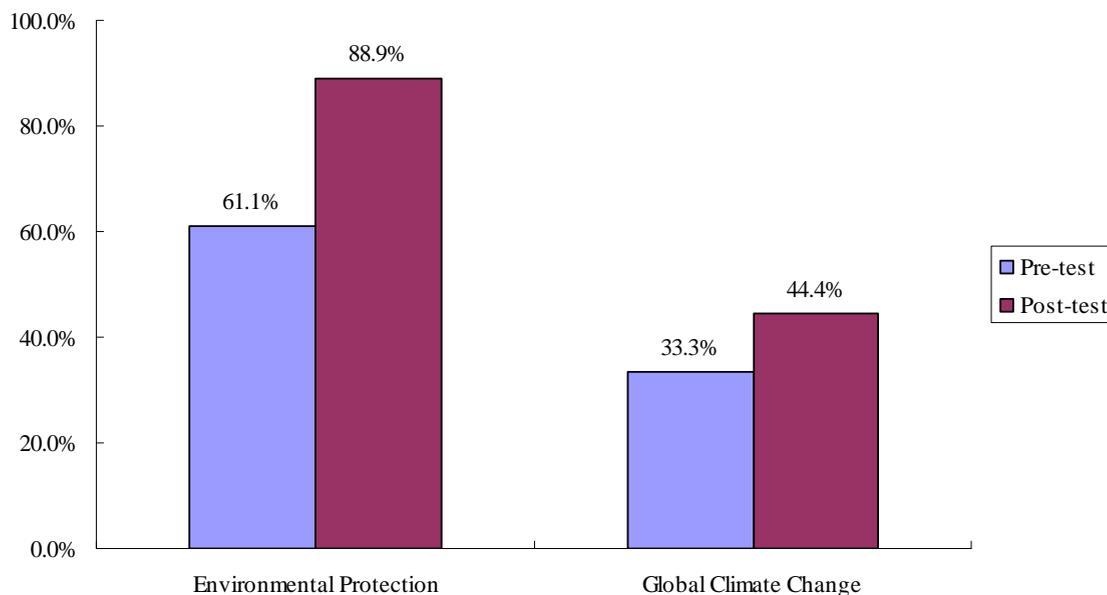
Moreover, the pre-test survey found that all of the respondents (n=18) believed that global climate change was real and had already started to happen. They expressed a moderate level of concern about potential climate-change impacts with an average score of 4.4 points on a 6-point Likert scale (a higher score indicates a higher level of concern). The respondents then scored 4.7 points in the post-test survey (slightly higher than the pretest survey).

Finally, the pre-test survey highlighted that the respondents believed in anthropogenic factors in inducing global climate change. They assessed their level of agreement that human activities are the main driving force behind global climate change with an average score of 4.1 points on a 5-point Likert scale (a higher score indicates a higher level of agreement). The average score in the post-response increased to 4.5 points.

#### Attitudes—Political Priority

From a list of ten public issues, the respondents were requested to select three top prioritized issues for the government to take immediate action, namely environmental protection (61%), the gap between the rich and the poor (56%), and economic growth (39%). They were further asked to select three top prioritized environmental issues. All of the four most frequently selected issues were locally orientated: water pollution (61%), air pollution (44%), natural ecosystem destruction (44%), and solid waste and recycling (44%). Only 33% of them considered global climate change to be a prioritized issue.

This result implies that even if the respondents recognized environmental protection as a prioritized public issue, they did not necessarily relate their awareness to global climate change. In addition, comparison of the pre- and post-test responses found that the percentage that selected environmental protection and global climate change increased, respectively, from 61% to 89% and from 33% to 44% (Figure 5.1).



**Figure 5.1** Difference of the percentage of the respondents support for the prioritized issues in the pre- and post-surveys in Taiwan (n=18).

#### Attitudes—Blame and Responsibility

The respondents agreed that industrialized countries are responsible for global climate change and these nations should take more responsibility to resolve the problem. The average score with respect to the level of agreement was 4.1 points on a 5-point Likert scale (a higher score indicates a higher level of agreement). In addition, the respondents thought that three entities with primary responsibility to resolve global climate change are industries, the government, and every citizen. These perceptions did not change significantly after the IA focus groups.

#### Attitudes—Personal Relevancy Index (PRI)

The Personal Relevancy Index (PRI) consists of three items that indicate how the respondents assessed their relationship to global climate change in terms of personal contributions, impacts, and actions with a 5-point Likert scale (a higher score indicates

that they feel more relevant to the problem). While they agreed that global climate change may affect them personally during their lifetime (4.3 points), they displayed a lower level of agreement with the notion that their daily activities contribute to climate change (3.7 points).

While the respondents agreed that they may be relevant to the causes and consequences of climate change, they thought that the problem is so overwhelming that it is beyond the control of young people such as themselves (2.5 points).<sup>67</sup> In other words, they felt there was little efficacy in the potential actions that a person could contribute. This helplessness and powerlessness can be explained by the strength of psychological barriers and the invocation of a denial mechanism (Lorenzoni et al., 2007; Stoll-Kleemann et al., 2001). While the respondents felt they had more personal relevancy regarding climate change in terms of contributions and actions (both scores slightly increased), a comparison of pre- and post-test results found no significant difference on all three items.

#### Attitudes—Economic Tradeoff

The last question in the general concern section asked respondents to take a position on the presumed trade-offs between economic growth and the environment. A total of 78% of them thought that both economic and environmental goals are important, but the environment should come first and 11% thought the environment should get the highest priority. A further 11% placed the economy ahead of the environment though they recognized both goals to be important. None of the respondents gave the highest priority

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<sup>67</sup> This item is negatively worded which means that the disagreement with the statement would be recorded as 5 points. The item was then reworded in the online survey.

to promoting economic growth. This result shows that most respondents endorsed a pro-environmental attitude. This attitude did not change significantly on the post-test survey.

*Scientific Knowledge—Causes, Impacts, and Mitigation Strategies*

The respondents were asked to identify correct causes, impacts, and mitigation strategies for global climate change from a list of actual and bogus queries. If an individual successfully identified the correct answer (or did not select a bogus option), the response was recorded as a correct answer and scored as one point. The overall score on a particular question depended on the number of correct answers the respondent was able to provide. The maximum score for the question on causes and mitigation strategies was 10 points and the maximum score for the question on impacts was 11 points.

The pre-test survey found that the respondents displayed relatively limited knowledge about the causes and mitigation strategies associated with climate change, in comparison to the impacts. First, they scored on average 68.3% on the causes. This result indicates that out of 10 options, they answered an average of 6.8 items correctly, with a range of 4 and 10 points. Among 10 choices, most respondents successfully identified a number of straightforward causes of climate change, namely deforestation (100%), industrial GHG emissions (94%), the use of fossil fuels in thermal power plants (89%), and the individual use of automobiles (78%).

Interestingly, while they recognized the impacts of thermal power plants, some respondents did not relate electricity consumption to the direct causes. A total of 67% correctly identified household-electricity consumption and 50% correctly identified industrial electricity consumption as a contributor to climate change. In addition, as to

four bogus options, more than half of the respondents were able to eliminate nuclear plants (72%) and pesticides (67%). However, smaller percentages correctly ruled out the use of aerosol spray cans (50%) and ozone depletion (17%).

Second, the respondents on average scored 83.3% on the questions about climate-change impacts which means that out of 11 options they answered an average of 9.2 items correctly, with a range of 7 and 11 points. Most respondents could correctly identify most of the listed impacts, namely sea-level rise (100%), melting glaciers (100%), increasing global temperatures (94%), changes in precipitation volume (94%), increasing extreme weather (83%), and decreasing biodiversity (83%).

Large percentages were also able to exclude bogus options, such as decreasing vector-borne diseases (94%), increasing pesticide residues in foods (89%), and increasing radioactive waste (89%). While a total of 50% of the respondents correctly identified decreasing agricultural productivity as an impact, only 39% ruled out the bogus item on the question pertaining to increasing chances of skin cancer due to exposure to excessive ultraviolet light (39%).

Finally, the respondents on average scored 72.2% on the mitigation strategies, which means that out of 10 options they answered an average of 7.2 items correctly, with a range of 5 and 9 points. Most of the respondents successfully identified a number of actions that could likely moderate the effects of climate change, namely reforestation (94%), conserving energy and electricity (94%), developing energy-efficient products (89%), using public transportation (89%), and constructing renewable energy power plants (89%).

More than half of the respondents correctly excluded three bogus options: reducing nuclear power generation (78%), decreasing pesticides use (72%), and limiting use of aerosol spray cans (50%). While a total of 61% of the respondents correctly selected carbon capture and storage technology (i.e., storing CO<sub>2</sub> underground), only 6% (one respondent) was able to identify another geo-engineering option: deploying large mirrors to reflect some solar energy into space.

Therefore, the respondents seem to have had better ability identifying climate-related impacts than causes and mitigation actions. Interestingly, comparison of the pre- and post-survey data shows that there was no significant improvement in correct identification of these three aspects. In fact, while scores on the impacts slightly increased from 83.3% to 86.9%, both the causes and mitigation strategies received slightly decreased scores after the IA focus groups (Table 5.1).

**Table 5.1** Pre- and Post-Scores of on the Scientific Knowledge Section (n=18)

Question	Q 2.1		Q 2.2		Q 2.3		Q 2.4	
Content	Causes		Impacts		Mitigation		Science	
No. of Items	10		11		10		15	
Pre and Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Ave Score	68.3%	66.7%	83.3%	86.9%	72.2%	70.6%	53.7%	78.1%
Max Score	10	10	11	11	9	9	14	15
Min Score	4	4	7	6	5	4	3	7

### *Scientific Knowledge—Advanced Scientific Understanding*

The second part of the scientific knowledge section was a 15-item test comprising a series of advanced factual scientific statements on climate science and policy science (i.e., the greenhouse effect phenomenon, global CO<sub>2</sub> emission trends and scientific observation, future projections, international agreements, Taiwan's energy use and CO<sub>2</sub> emissions)

(see Table 5.2). Six bogus queries were inserted into these 15 items (item no. 2, 4, 7, 11, 12, and 14). The respondents were asked to appraise whether each statement was true or false. Successfully selecting the correct query with “true” and the bogus query with “false” is recorded as a correct answer and scored with one point. Choosing the “do not know” option is considered as an incorrect answer. The maximum score for this part was 15 points.

The pre-test survey found that the respondents on average scored 53.7% on advanced scientific knowledge, which means that out of 15 items they answered an average of 8.1 items correctly, with a range of scores between 3 and 14 points. The percentage of the respondents that correctly answered each item varied from 94% (item no. 14) to 17% (item no. 6) (Table 5.2). The results also show inconsistency and variation of scientific understanding on each variable.

First, while 72% of the respondents recognized that the greenhouse effect is a natural phenomenon (item no. 1), only 33% knew the effect is not due to the reabsorption of outgoing ultraviolet rays by GHG (item no. 2).

Second, 61% understood correctly the effect of CO<sub>2</sub> emissions since the start of the Industrial Revolution (item no. 3) and 83% knew that CO is not a greenhouse gas. However, only a few respondents knew the exact extent of projected temperature increase (28%) (item no. 5) and the exact degree of anticipated sea-level rise (17%) (item no. 6).

**Table 5.2** Percentage of the Respondents Answer Correctly in Each Item in the Pre- and Post-Surveys (n=18)

Item	Pre	Post	Diff.
1. The greenhouse effect is a natural phenomenon that moderates the earth's average surface temperature within a relatively comfortable range.	72%	94%	+22%
2. The greenhouse effect is due to the reabsorption of outgoing ultraviolet rays by atmospheric greenhouse gasses.	33	56	+22
3. The global atmospheric concentration of carbon dioxide has increased 35% since the Industrial Revolution during the middle of the nineteenth century. The increase exceeded the range of natural variability in the earth history.	61	83	+22
4. The most important and abundant anthropogenic greenhouse gas is carbon monoxide.	83	100	+17
5. The average global temperature has risen 0.76 degrees Celsius over the past 150 years.	28	50	+22
6. The global average sea level rise during the twentieth century is estimated to have been 0.17 meters.	17	56	+39
7. If the global concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, further warming could be stopped.	44	56	+11
8. If humans continue to use fossil fuels and to emit greenhouse gasses at or above current rates, the global average temperature is projected to rise approximately 4 degrees Celsius by the end of the current century.	50	78	+28
9. If humans continue to use fossil fuels and to emit greenhouse gasses at or above current rates, the global average sea level is projected to rise 0.26-0.59 meters by the end of the current century.	28	61	+33
10. The main purpose of the Kyoto Protocol is to reduce carbon dioxide emissions in the industrialized countries by an average 5.2% below their levels in 1990.	33	89	+56
11. Taiwan has ratified the Kyoto Protocol.	72	100	+28
12. The majority of Taiwan's energy supply is derived from nuclear energy.	50	56	+6
13. The major contributor of carbon dioxide emissions (including direct emission and indirect electricity consumption) in Taiwan is the industrial sector.	61	100	+39
14. Since 1990 the total carbon dioxide emissions of Taiwan has stopped increasing.	94	100	+6
15. Taiwan's carbon dioxide emission per capita (per person) is above the world's average.	78	94	+17
Grand Mean	53.7%	78.1%	+24.4%

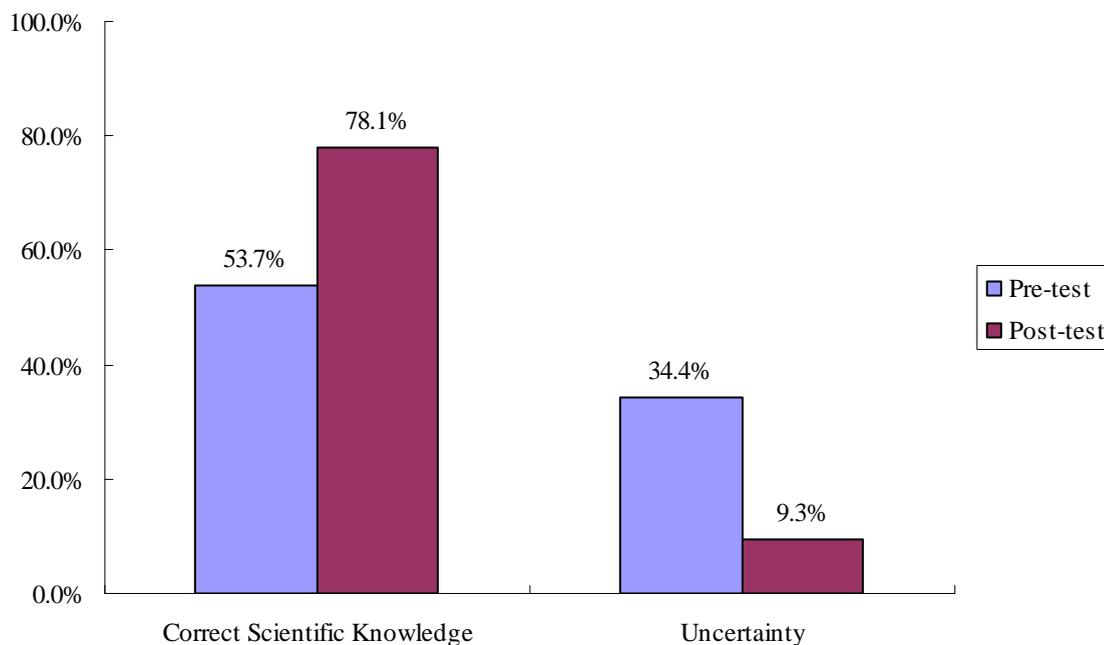
Third, the respondents did not perform very well on questions about future projection of climate change. Less than half (44%) of the respondents recognized that even if the global GHG concentration had been kept constant at year 2000 levels, there would still be future warming (item no. 7). While half of the respondents knew the projected temperature increase in the 21st century (item no. 8), only 28% recognized the estimated extent of sea-level rise during the same time period (item no. 9).

Fourth, 33% of the respondents knew the target and the timetable of the Kyoto Protocol (item no. 10) and 72% knew that Taiwan has not ratified the treaty (item no. 11). Finally, the respondents displayed better understanding of the queries regarding Taiwan's energy use and CO<sub>2</sub> emissions. Half of them correctly knew that nuclear power is not Taiwan's primary energy source (item no. 12) and 61% correctly recognized the industrial sector as the primary contributor of the country's GHG emissions (item no. 13). A total of 94% of them knew Taiwan's releases have continually increased since 1990 (item no. 14) and 78% knew that the country's CO<sub>2</sub> emissions per capita are above the world's average (item no. 15).

Furthermore, comparison of the pre- and post-responses found that the respondents' level of scientific understanding improved significantly and uncertainty decreased dramatically after the workshop (Figure 5.2). Even though their understandings of the causes, consequences, and mitigation actions associated with climate change were not significantly improved, the level of factual scientific knowledge in each item did display differences, ranging from 6% to 56% (see the last column of Table 5.2).

The post-test survey found that the respondents answered on average 11.7 items out of 15 items correctly, with a range of answers between 7 and 15 points. The average

correctness rate progressed from 53.8% in the pre-test to 78.1% in the post-test (Figure 5.2), which means that if it is a quiz, the students' average performance improved from a failing score to a broadly satisfactory score.



**Figure 5.2** The difference of the level of correct scientific knowledge and uncertainty in the pre- and post-surveys (n=18).

In contrast, if reviewing the “do not know” option separately, it is found that the respondents did not know the answers on an average of 5.2 items in the pre-test, which means that they did not know one third of the 15 items (uncertainty rate: 34.4%). This uncertainty condition substantially decreased in the post-test—the respondents did not know the answers to an average 1.2 items (uncertainty rate: 9.3%) (Figure 5.2). In addition, the average percentage of respondents that did not know the answer per item declined from 6.2 (people per item) in the pretest to 1.7 in the post-test.

Moreover, the uncertainty was primarily improved on queries regarding scientific observation and future projection of climate change (item no. 5, 6, 9, and 10). More than half of the respondents did not know the answers to these items in the pre-test, but they were more confident in answering in the post-test. These items include the exact degree of sea-level rise (from 78% to 28%), the exact degree of global temperature increase (from 72% to 33%), future sea-level rise projection (from 61% to 22%), and the target and timetable of the Kyoto Protocol (from 61% to 6%).

#### *Individual Responses—Taiwan's Commitment to Reduce GHG emissions*

The respondents were first asked about their personal opinions about whether Taiwan should commit to reduce its GHG emissions and the reasoning behind their choices. The pre-test survey found that all respondents except one thought that Taiwan should actively begin to reduce its GHG emissions. From a list of five reasons (respondents were allowed to select more than one reason), most of them (94%) supported the government's commitment from an ethical perspective.

Those who endorsed an ethical attitude argued that as a member of the global community Taiwan does not have a moral right to destroy the environment. In addition, 76% of the respondents based their reasoning on Taiwan's high GHG emissions per capita and high vulnerability to adverse impacts. Approximately half of them believed that the country would benefit economically from taking actions in the long term. Only 29% argued their reasoning out of fear of facing trade sanctions from the rest of the world. This perception changed slightly in the post-response in which all 17 respondents selected the option of high GHG emissions per capita.

### Individual Responses—Willingness to Change Behaviors

The respondents were then instructed to self-evaluate their willingness to take certain personal behavior changes to reduce CO<sub>2</sub> emissions on a 5-point Likert scale (a higher score indicates a higher level of willingness). Review of each action reveals a slight variation. The respondents expressed a high level of willingness to use less air conditioning and to drive fewer miles by personal vehicles (average 4.4 points), but they were not so enthusiastic about paying more for renewable energy (3.4 points) and showed only medium level of willingness (average 4.2 to 4.3 points) to take the rest of three actions (i.e., use electricity less, buy energy efficient products, and reduce their use of personal vehicles).

Aggregating all six actions into a composite index, the pre-test result shows that respondents were quite willing to change their behavior to reduce CO<sub>2</sub> emissions with an average rating of 4.2 points with individual ratings ranging between 3.5 and 5.0 points. However, the change of respondents' preparedness to take climate-protection behaviors after the workshop was not significant.

### Individual Responses—Experiences

The respondents were asked to indicate their own experiences with having taken certain actions on a 4-point Likert scale (a higher score means more frequently). The results suggest that they would conduct these actions fairly frequently with an average of 3.6 points, ranging between 2.8 and 4.0 points. In addition, the respondents were more likely to use public transportation (3.8 points) than to turn off the lights when leaving a room (3.7 point) than to use air conditioning less and to turn off the computer (3.4 points).

### Individual Responses—Willingness to Take Political Actions

The respondents were further asked to assess their willingness to take certain political or social actions to motivate the government to act on reducing the country's CO<sub>2</sub> emissions on a 5-point Likert scale (a higher score indicates a higher level of willingness). Pooling all five actions into a composite index, the pretest results show that the respondents expressed a medium level of willingness to take political actions with a rating average of 3.9 points with individual ratings ranging between 3 and 5 points.

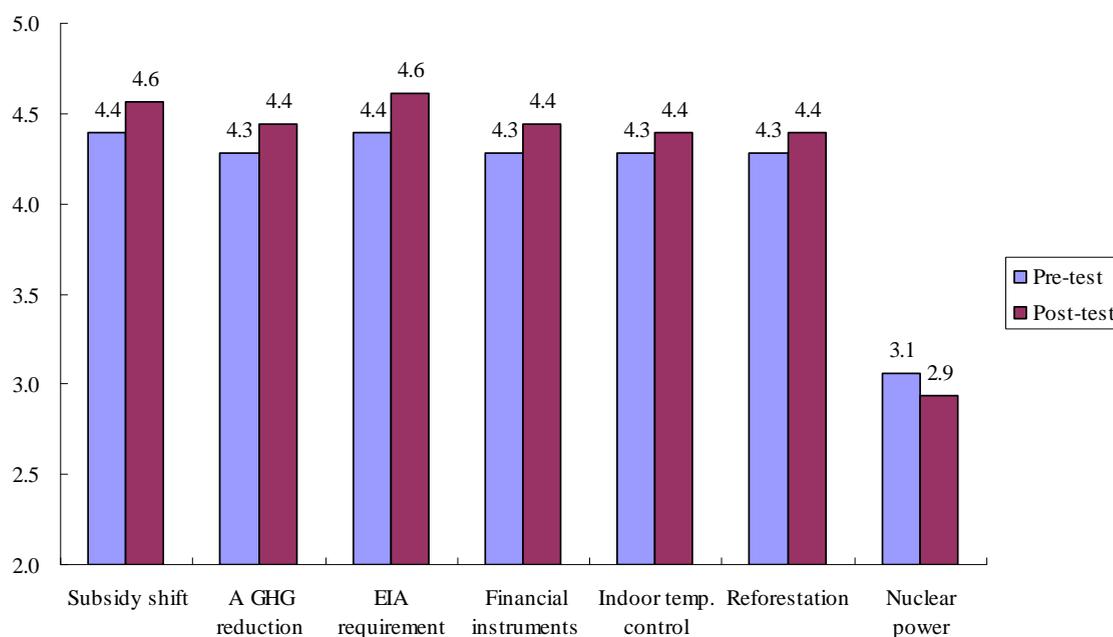
The respondents were fairly willing to sign a petition (4.2 points), to vote for a political candidate with a strong environmental record (4.2 points), to join an environmental group (3.9 points), and to attend a public hearing (3.8 points). However, they were somewhat reluctant to participate in a legal street marching movement (3.3 points). Comparison of the pre- and post-responses finds no significant changes.

### Individual Responses—Policy Preferences Index

The final part of this section examined respondents' personal support for various climate-mitigation policies (e.g., a green industrial development plan, taxes and other economic incentives, a reforestation program, and a nuclear energy development plan). Consisting of seven initiatives, the Composite Policy Preferences Index (PPI) is measured on a 5-point Likert scale (a higher score indicates a higher level of support). The pre-test result showed that respondents displayed a medium level of support for these policies, with a rating average of 4.1 points with individual ratings ranging between 3.6 and 5.0 points.

The respondents basically supported all policies except the one asserting to use nuclear power as an alternative energy source. They showed a high level of support for a

policy that would shift government subsidies to less polluting industries (4.4 points) and that required consideration of GHG emissions as part of the environmental impact assessment (EIA) review process (4.4 points). In addition, the respondents scored on average 4.3 points in four other policies, namely a mandatory GHG regulation, financial instruments, a law regulating indoor temperature in summer, and a reforestation program. Finally, they expressed a neutral position (neither support nor opposition) about the nuclear power option (3.1 point). Comparison of pre- and post-surveys finds that although the respondents already expressed a relatively high level of support for mitigation initiatives in the pre-test, their support for six climate policies still increased after the workshop. The only exception was the nuclear power policy (Figure 5.3).



**Figure 5.3** The difference of the level of support for various climate policies in the pre- and post-surveys (n=18).

### Summary of Findings

This study of pre- and post-survey data aims to understand respondents' concern about

climate change (i.e., attitudes, scientific knowledge, behavioral intentions, and policy preferences) and to assess the effectiveness of the IA focus groups in changing the participants' overall level of understanding. The results show that after exposure to expert opinions and group interactions, these participants did change some viewpoints, such as their level of familiarity and concern, political priorities, and perceived personal relevance.

In addition, although the respondents' understandings of causes, consequences, and mitigation actions did not change, their factual scientific knowledge improved and their uncertainty decreased significantly. Moreover, the respondents' support for climate policies was enhanced. Therefore, the integration of scientific experts did appear to enhance some people's understandings of climate change quite effectively.

#### **5.2.4 Study 3: Web-based Survey**

##### *Summary of Approach*

To investigate Taiwanese university students' overall level of concern about climate change (i.e., attitudes, scientific knowledge, behavioral intentions, and policy preferences) and to explore the hypothetical relationships among these constituent elements, a larger-scale quantitative survey was carried out through a common medium for Taiwanese young people: the Internet. Potential respondents first received an electronic invitation that linked them to the survey site and they voluntarily selected to participate and to submit their responses via the online survey host *SurveyMonkey* (also see Section 4.6 for the detailed method).

Slightly modified from the pre- and post-survey, the web-based survey was designed using the same structure of four sections including general concern, scientific

knowledge, individual responses, and demographic information. To keep the completion time within approximately 10 minutes, the online instrument was shortened to a total of 40 items. In addition to various respondent-friendly formats (e.g., navigation signs, a progress bar), all questions were designed to require answers—a respondent was not allowed to proceed to the next question without entering an answer.

The study collected a total of 313 entries that started the survey and 28 out of 313 entries were incomplete—the respondents dropped out from the survey. The survey only counts the rest of the 285 completed responses as valid samples ( $n=285$ ). The comprehensive survey instrument and the response frequencies are provided in Appendix B. This section reports the descriptive statistics of the survey results and further statistical analysis (using the *Minitab* software) will be presented in the next section.

#### *Characteristics of the Respondents*

A total of 285 university students participated in this web-based survey. Table 5.3 shows the response count and the frequency of key characteristics of the respondents. First, among these respondents, 77.2% were young people between the ages of 18 to 22 years (a normal range of Taiwanese undergraduate students) and 22.5% were between the ages of 23 to 30 years. Only one respondent (0.4%) was above 30 years old.

Second, female students (60.4%) comprised a larger proportion of the respondents than male students (39.6%). Third, a total of 81.8% of the respondents were undergraduates and 18.2% were graduate students (master degree: 15.1% and doctoral degree: 3.2%).

Fourth, in terms of respondents' academic majors, 34.7% of them had a background in scientific disciplines including science, engineering, and agriculture, while

a majority (51.2%) was specializing in the humanities, law, business, and social science. Additionally, 14.0% of the respondents identified their majors as “others” which include design, information, communication, and so forth. Finally, the hometowns of the respondents were geographically well-distributed across 23 out of 25 cities/counties in Taiwan. A total of 54.0% of the respondents were from 8 major metropolitan areas and 46.0% were from the remaining 15 counties.

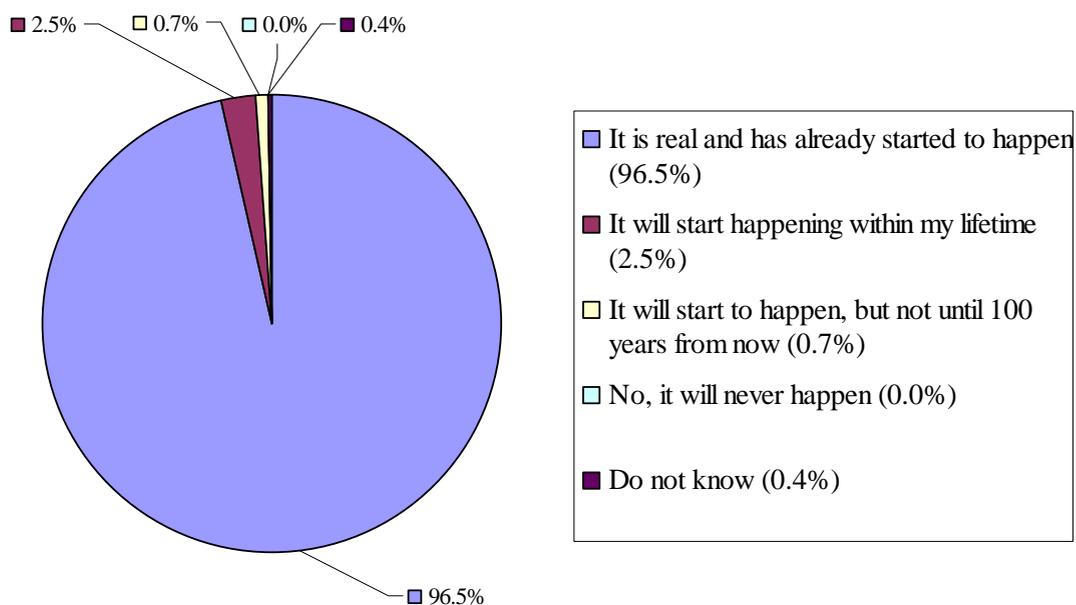
**Table 5.3** Response Count and Frequency of Key Characteristics of the Respondents (n=285)

	Gender		Class Year		Academic Major		
	Male	Female	Undergrad.	Graduate	Science	Non-science	Other
Count	113	172	233	52	99	146	40
Frequency	39.6%	60.4%	81.8%	18.2%	34.7%	51.2%	14.0%

### *Attitudes—Problem Recognition*

The respondents were first asked about their views regarding the reality of global climate change. The result shows that an overwhelming majority (96.5%) of Taiwanese university students (n=285) believed that global climate change is real and has already begun to become manifest (Figure 5.4). In addition, these respondents displayed a moderate level of concern about the potential adverse effects of climate change on a 5-point Likert scale (a higher score indicates a higher level of concern).<sup>68</sup> The rating average was 3.7 out of 5 points, which was slightly above a medium level. Examination of the response distribution further reveals that 57.5% of the respondents were very or mostly worried, 34.7% were concerned, and 7.4% were somewhat concerned or not concerned at all regarding climate change impacts.

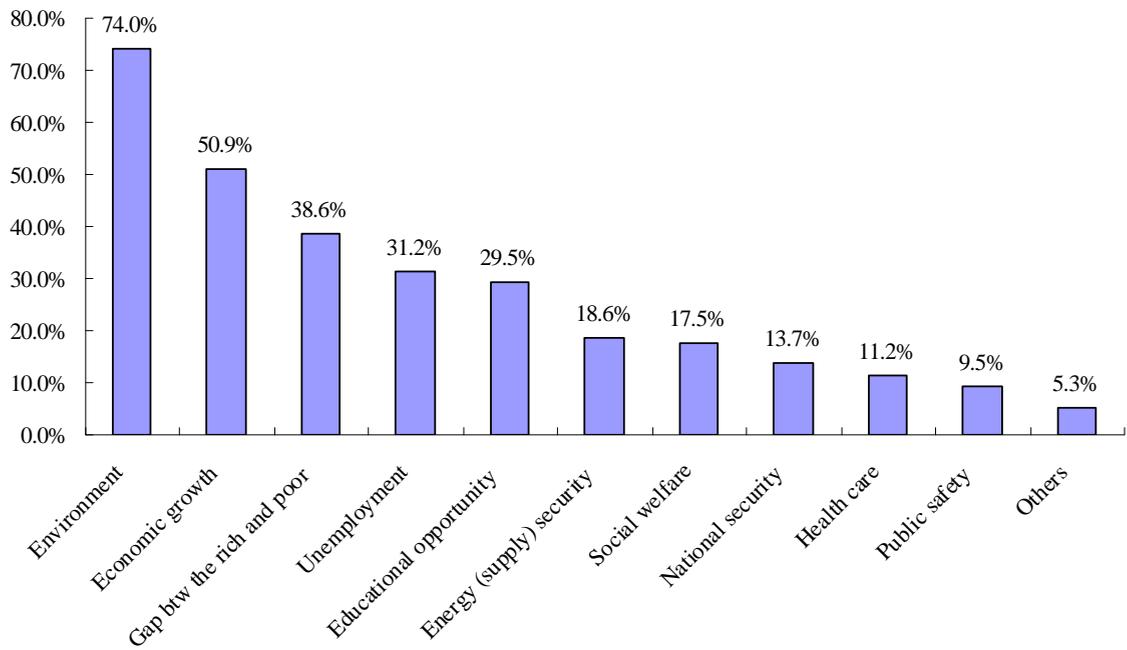
<sup>68</sup> The response was scored on a scale of one to five points: very concerned: 5; mostly concerned: 4; concerned: 3; somewhat concerned: 2; not concerned at all: 1.



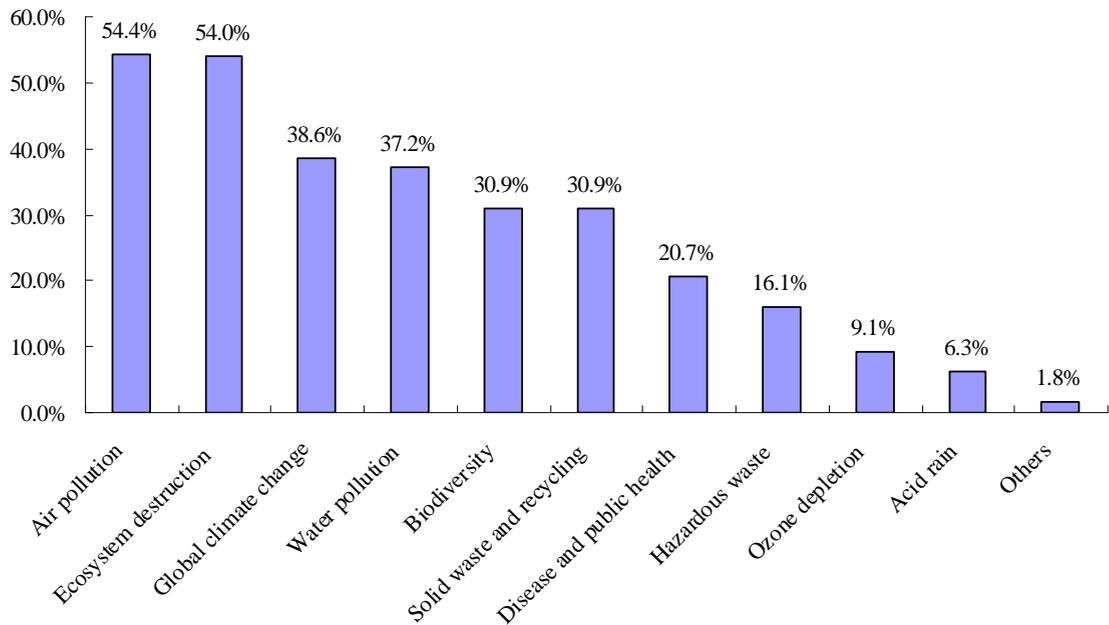
**Figure 5.4** Percentage distribution of problem recognition (n=285).

#### *Attitudes—Political Priority*

When the respondents were asked to select their top three policies for the Taiwanese government in terms of immediate actions to be taken, a total of 74% (n=285) selected the issue of environmental protection—the most recognized choice (Figure 5.5). In addition, three economic related issues (i.e., economic growth, gap between the rich and the poor, and unemployment) ranked, respectively, as the second (50.9%), the third (38.6%), and the fourth (31.2%) prioritized public policies. Interestingly, the other societal issues (e.g., education, social welfare, and health care) were considered less urgent and important (selected by less than 30% of the respondents).



**Figure 5.5** Frequency of prioritized public policies in Taiwan (n=285).



**Figure 5.6** Frequency of prioritized environmental policies in Taiwan (n=285).

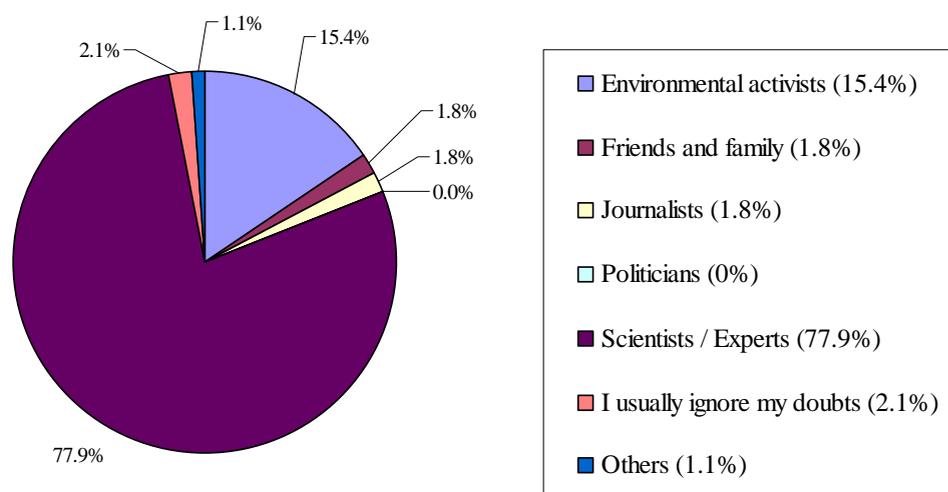
While most of the respondents placed the environmental protection issue as one of their top three policies, the issue of global climate change does not attract sufficient attention to be ranked as the top priority on the political agenda (Figure 5.6). The result shows that among ten environmental issues, a significant portion of the respondents (over 50%) thought that the Taiwanese government should take immediate actions on the issues of air pollution and natural ecosystem destruction. It is interesting to find that the respondents distributed their choices rather diversely to other issues—global climate change (38.6%), water pollution (37.2%), and solid waste and recycling (30.9%).

In addition, three global environmental problems (i.e., acid rain, climate change, and ozone depletion) did not draw much attention (average: 18.0%) compared with other local environmental problems (average: 34.9%). On the basis of these data, it can be inferred that although most Taiwanese university students recognize environmental protection as a prioritized policy, they tend to give greater attention to local environmental issues.

#### Attitudes—Trust in Scientists

The respondents were requested to identify one source of information that they tended to listen to if they had doubts about global climate change. A total of 77.9% of the respondents (n=285) indicated that they would turn to scientists or experts for enlightenment (Figure 5.7). The second most selected source of information was environmental activists (15.4%). Other sources (e.g., journalists, friends) were selected by less than 5% of the respondents. It is interesting to find that no respondents (0.0%) would listen to politicians' opinion about climate change.

In terms of the degree to which scientists are trusted, a total of 60.7% of the respondents trusted this source of expert opinion at a high level (completely or mostly) and 29.5% trusted at a medium level (some), and 9.1% did not have much trust in scientists. On a 5-point Likert scale (a higher score indicates a higher level of trust), Taiwanese university students rated their level of trust with an average of 3.6 points.



**Figure 5.7** Percentage distribution of the top trusting source of information (n=285).

### Attitudes—Blame and Responsibility

Two rating-scale questions were designed to assess respondents' level of agreement regarding the anthropogenic factors of global climate change and the distribution of responsibility between industrialized countries and developing countries. Taiwanese university students expressed a high level of agreement with a rating average of 4.3 points on a 5-point Likert scale (a higher score indicates a higher level of agreement). In addition, a total of 86.7% of the respondents (n=285) concurred that human activities are

the main driving force behind the problem, while only 2.5% disagreed with the statement. The remaining 10.9% neither agreed nor disagreed with the statement.

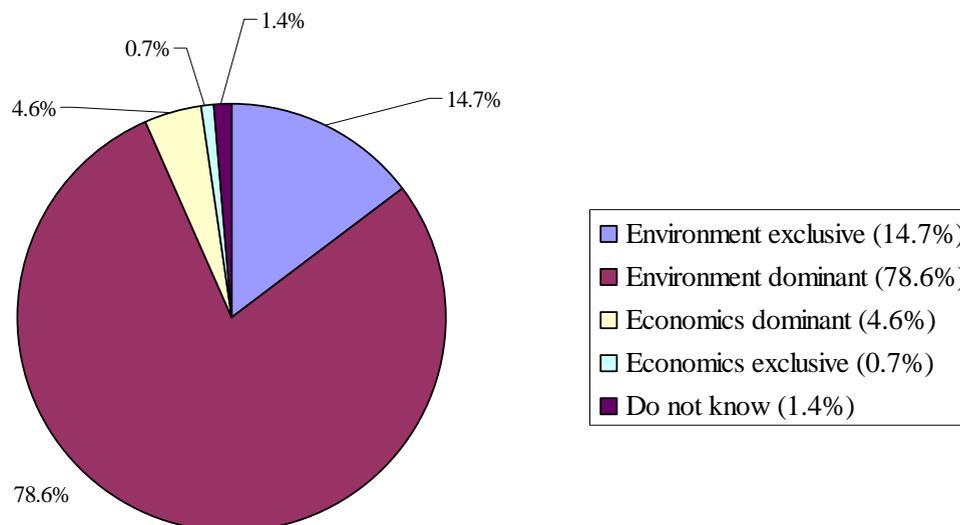
When asked to evaluate opinions about the key concept of the principle of common but differentiated responsibilities, Taiwanese university students exhibited a moderate attitude with a rating average of 3.7 points. Moreover, 63.9% of the respondents agreed that industrialized countries should primarily be held responsible for global climate change and they should exert more individual effort to address the problem than developing countries. A relatively small number of the respondents disagreed with the idea (15.8%), but 20.4% neither agreed nor disagreed with the concept.

The issue of citizenship was also observed when posing the question about which sector in Taiwan needed to bear primary responsibility to reduce GHG emissions. While 14.7% of the respondents thought the industrial sector should be held liable for resolving the problem, a majority (83.2%) recognized that both they (household/consumer sector) and the industry sector were equally responsible. Only 1.8% of them placed the burden solely on the household/consumer sector.

#### *Attitudes—Economic Tradeoff*

When asked about their views with respect to a potential trade-off between economic development and environmental protection, 78.6% of the respondents thought that even though both environment and economic goals are important, the environment should be placed first (Figure 5.8). Another 14.7% gave the highest priority to protecting the environment even if it reduces economic growth. Only approximately 5% of the respondents valued the economy over the environment. Even though the question was an abstract scenario that did not require further comparisons and assessments, the result still

implies that Taiwanese university students tend to have a pro-environmental attitude because of their overwhelming preference in protecting the environment (93.3%).



**Figure 5.8** Percentage distribution of the economy-environment tradeoff (n=285).

#### Attitudes—Personal Relevancy Index (PRI)

The Personal Relevancy Index (PRI), a composite Likert scale of three items, was designed to measure how respondents evaluated the relationship between themselves and the issue of climate change in terms of causes, impacts, and actions. The respondents were asked to provide their personal assessment of the level of agreement with each of these three statements on a scale of one to five points (a higher score indicates a higher level of agreement and hence they feel more relevant to the problem). Table 5.4 illustrates the content of each item, the percentage distribution, and the rating average of these self-evaluated items.

**Table 5.4** Percentage Distribution and Rating Average of the Personal Relevancy Index (n=285)

	A* 5**	SA 4	N 3	SD 2	D 1	DK m	Rating Ave.
1. My daily activities contribute to global climate change	<b>9.5%</b>	<b>62.1</b>	20.4	7.0	0.4	0.7	<b>3.7</b>
2. Global climate change may impact me personally in my lifetime	<b>34.7</b>	<b>58.6</b>	6.0	0.7	0.0	0.0	<b>4.3</b>
3. There is still something a young person such as me can do to contribute to resolve the problem of global climate change.	<b>43.2</b>	<b>49.8</b>	6.3	0.0	0.0	0.7	<b>4.4</b>

\*A: Agree, SA: Somewhat Agree, N: Neither Agree nor Disagree, SD: Somewhat Disagree, D: Disagree, DK: Do not Know

\*\* The scoring for each level was recorded from 1 to 5 points. DK was recorded as a missing value.

Combining the choices of “agree” and “somewhat agree,” most of the respondents (n=285) agreed that global climate change may affect them personally in their lifetime (93.3%) and concurred that there is still something a young person can do to contribute to resolving the problem (93.0%). Interestingly, a relatively smaller portion of the respondents (71.6%) recognized that their daily activities contributed to the problem. Moreover, 20.4% held an ambivalent position—neither agreed nor disagreed with their personal contribution. These results reveal that majorities of the respondents concurred that climate change was relevant to them personally.

The second way to evaluate perceived relevancy is via the rating average of each item and the composite index.<sup>69</sup> This study designed the PRI as one of the indicators of attitude for further statistical analysis (i.e., testing the relationships among a person’s

<sup>69</sup> Internal validation is defined as the process whereby the individual items composing a composite measure are correlated with the measure itself (Babbie, 1990). In other words, each individual item in a composite index should measure the same variable. Item analysis is an important test tool of the index’s validity by reviewing correlations between a single item and the composite index. A higher value of Cronbach’s alpha indicates a higher internal consistency. If an item is poorly correlated to the index, that item should be excluded from the index. Omitting the item will increase the Cronbach’s alpha value.

attitude, scientific knowledge, and responses) and it is essential to validate this composite index. Item analysis is employed to test the PRI's internal consistency. The result shows a satisfactory internal consistency (Cronbach's  $\alpha=0.59$ ) with item-total correlations ranging between 0.35 and 0.40. Since omitting any item lowers the value of Cronbach's  $\alpha$ , the PRI retains use of these three items.

The last column of Table 5.4 shows that the respondents displayed a fairly high level of perceived relevancy in terms of potential impacts and actions with the rating average of 4.3 and 4.4 points (out of 5). Similar to the percentage distribution, they scored relatively lower for the first item (3.7 points). The overall rating average of the PRI was 4.1 points with individual rating averages ranging from 2.7 to 5.0 points. These data imply that while Taiwanese university students recognize that climate change may affect them personally and that they can take some actions, some of them do not think their daily activities contribute to the problem.

#### Scientific Knowledge—Scientific Understanding Index<sup>70</sup>

The condensed online survey selected twelve dichotomous questions to assess respondents' scientific understanding of climate change. The respondents were asked to answer whether these twelve scientific statements were true or false (Table 5.5). These statements primarily cover two dimensions: physical science (10 items) and policy science (2 items). Additionally, the physical science dimension was constructed with four variables: the greenhouse effect (item 1), causes (item 2, 3, and 4), adverse impacts (item 5, 6, and 7), and mitigation strategies (item 8, 9, and 10). The remaining two items (item

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<sup>70</sup> Scientific Understanding Index is a 12-item composite index that measures the level of scientific knowledge of global climate change. Because the nature of continuous data, it does not proceed the item analysis.

11 and 12) were intended to test policy relevant knowledge (i.e., the Kyoto Protocol and Taiwan's CO<sub>2</sub> emissions).

**Table 5.5** Percentage Distribution of the Scientific Understanding Index (n=285)

Scientific Statement	Correct Rate	Incorrect Rate <sup>b</sup>
1. The greenhouse effect is due to the reabsorption of outgoing infrared radiation by atmospheric greenhouse gasses, such as carbon dioxide.	78.9%	21.1%
2. Industrial manufacturers emitting greenhouse gases during the production process contributes to global climate change.	87.7	12.3
3. Ozone layer depletion contributes to global climate change. <sup>a</sup>	35.1	64.9
4. Deforestation contributes to global climate change.	90.9	9.1
5. Increasing average global air and ocean temperatures are a potential consequence of global climate change.	95.1	4.9
6. Global climate change has no effect on the change in precipitation volume (i.e., increasing flood and drought, water resource shortage). <sup>a</sup>	86.0	14.0
7. Global average sea-level rise due to the melting glaciers and ice cap in mountain and polar region is a potential consequence of global climate change.	96.1	3.9
8. People using public transportation could likely moderate the effects of global climate change.	92.3	7.7
9. Industries implementing carbon capture and storage technology (i.e., storing carbon dioxide underground or in the oceans) could likely moderate the effects of global climate change.	64.6	35.4
10. Power plants using sources of renewable energy instead of fossil fuels like oil and coal to generate electricity could likely intensify the effects of global climate change. <sup>a</sup>	52.6	47.4
11. The main purpose of the Kyoto Protocol is to reduce carbon dioxide emissions in the industrialized countries.	90.2	9.8
12. Taiwan's carbon dioxide emission per capita (per person) is above the world's average.	66.3	33.7
Grand Mean	78.0%	22.0%

a: Item no. 3, 6, and 10 are reversely worded: the selection of false is considered a correct answer.

b: The selection of the option "Do not Know" is categorized as an incorrect answer.

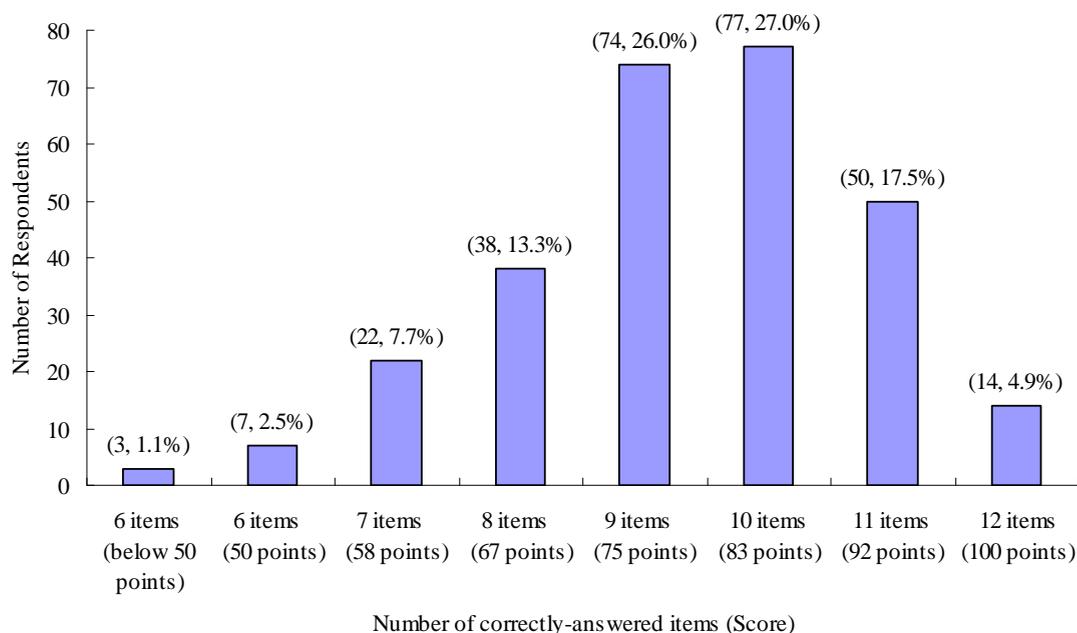
These twelve statements comprise both actual and bogus queries. If a respondent successfully identified an actual query as “true” or selected a bogus query with “false,” the response was recorded as a correct answer. Table 5.5 reports the percentage distribution of the Scientific Understanding Index (SUI). It is important to mention that three reverse-worded items (item 3, 6, and 10) have been recoded so the correctness rate presented here indicates the percentage of respondents that answered the item correctly.

Examining the response of each item, it was found that the average correctness rate for these 12 items was 78.0% with a range of 35.1% (item 3) to 96.1% (item 7). Most of the respondents (above 80%) were able to correctly answer seven items (item 2, 4, 5, 6, 7, 8, and 11). In addition, a significant portion of the respondents (above 30%) mistakenly answered four items (item 3, 9, 10, and 12). The low correctness rate of the question regarding ozone depletion (item 3) suggests that Taiwanese university students have a tendency to confuse the problem of global climate change with the problem of stratospheric ozone depletion.

In terms of average performance in the physical science dimension, a total of 78.9% of the respondents correctly answered the question regarding the greenhouse effect (item 1). In addition, they answered with high effectiveness on the potential consequence aspect (item 5, 6, and 7) (92.4%), with modest effectiveness on the cause aspect (item 2, 3, and 4) (71.2%), and low effectiveness on the mitigation-strategy aspect (item 8, 9, and 10) (69.8%). Furthermore, a total of 90.2% recognized the main purpose of the Kyoto Protocol as reducing CO<sub>2</sub> emissions in industrialized nations (item 11), and somewhat fewer respondents (66.3%) knew that Taiwan’s CO<sub>2</sub> emissions per capita are above the global average (item 12).

Reviewing responses to the “Do not know” option, 22.1% of the respondents did not know the answer to two relatively difficult questions. These two items involved a specific technology (carbon capture and storage) (item 9) and specific information (Taiwan’s CO<sub>2</sub> emissions per capita) (item 12). The higher uncertainty and the lower correctness rate (64.6% and 66.3%) for these two items imply that Taiwanese university students have less understanding of the detailed issues pertaining to climate change.

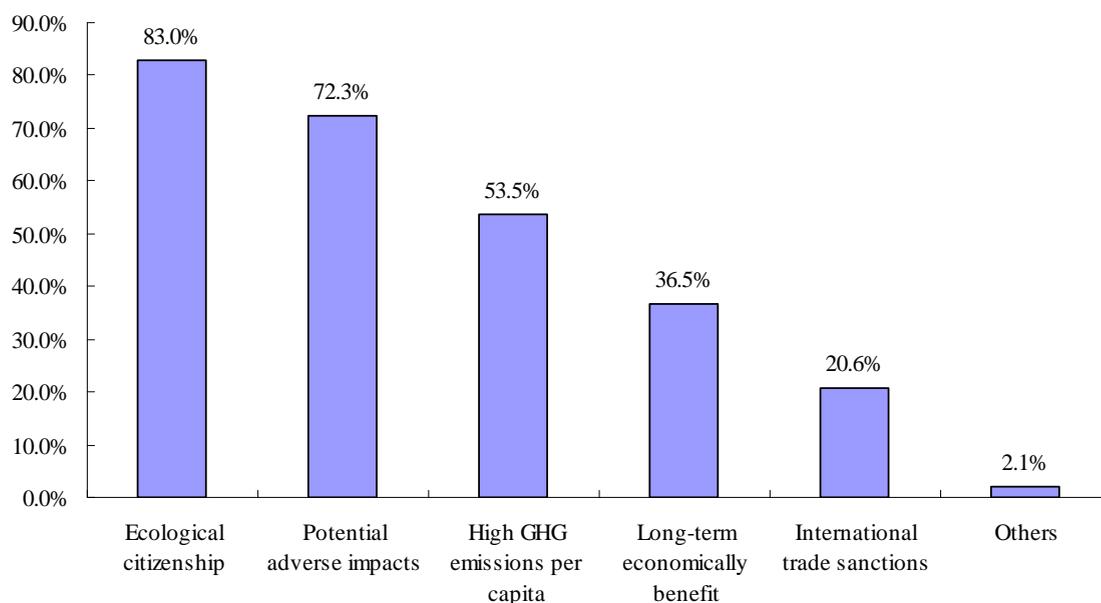
The respondents correctly answered an average of 9.4 out of 12 items with a range between 4 and 12 items. Transferring to a scale of 100, the average score is 78.0 points with a range of 33.3 to 100.0 points. A total of 4.9% of the respondents got a perfect score and 44.6% had an above average score (80-100 points). Another 39.3% of the respondents got a middling score (60-80 points) while 11.3% received a failing score (below 60 points) (Figure 5.9).



**Figure 5.9** Distribution of performance in 12-item Scientific Understanding Index (n=285).

*Individual Responses—Taiwan's Commitment to Reduce GHG emissions*

The respondents asserted with nearly unanimous support (98.9%) that Taiwan should begin to reduce its GHG emissions. When asked about the reasons why Taiwan needed to reduce its GHG emissions (multiple answers allowed), a total of 83.0% of the respondents based their reasoning on ecological citizenship: as a member of the global community the country does not have the right to destroy the global environment (Figure 5.10). The second and third most common reasons were concerns of risk from potential impacts resulting from global climate change (72.3%) and high GHG emissions per capita (53.5%). Pragmatic grounds like the long-term economic benefits and potential international trade sanctions were selected by very few Taiwanese university students.



**Figure 5.10** Percentage distribution of reasons to reduce GHG emissions in Taiwan (n=282).

*Individual Responses—Willingness to Change Behaviors*

The respondents were asked to assess their level of willingness to change certain personal

behaviors to reduce CO<sub>2</sub> emissions on a 5-point Likert scale (a higher score indicates a higher level of willingness). The Personal Behavior Index (PBI) is a composite measure of three items (i.e., conserving energy, using public transportation, and choosing energy efficient appliances) (Table 5.6). Slightly more than 80% of the respondents intended to conserve energy by reducing electricity consumption and by driving personal vehicles less and using public transportation. Relatively fewer respondents (74.4%) were willing to replace old appliances with energy efficient new models.

**Table 5.6** Percentage Distribution and Rating Average of the Personal Behavior Index (n=285).

	W*	SW	N	SU	U	Rating Ave.
	5**	4	3	2	1	
1. Conserve energy by reducing my use of electricity	<b>34.0</b>	<b>48.1</b>	17.2	0.7	0.0	<b>4.2</b>
2. Drive my car/motorcycle less and use public transportation (e.g., trains and buses) instead	<b>41.1</b>	<b>41.8</b>	14.7	1.8	0.7	<b>4.2</b>
3. Replace my older appliances with more energy efficient new models	<b>32.3</b>	<b>42.1</b>	23.5	1.8	0.4	<b>4.0</b>

\*W: Willing, SW: Somewhat Willing, N: Neutral, SU: Somewhat Unwilling, U: Unwilling

\*\* The scoring for each level was recorded from 1 to 5 points.

The other way to evaluate the respondents' willingness to support behavioral changes is via the rating average of each item and the composite index. The preliminary result finds that Taiwanese university students were willing to conduct these three behaviors with a rating average of 4.2, 4.2, and 4.0 points (see the last column in Table 5.6). Administering the testing process of internal consistency, the result of item analysis of the PBI shows a satisfactory internal consistency (Cronbach's alpha=0.61) with item-total correlations ranging between 0.34 and 0.48. The test also suggests that omitting the third item (green consumption) improves the validity of the index (Cronbach's alpha

slightly increases to 0.62). Thus, the revised index uses only the first two items for further analysis. The resulting rating average of the two-item PBI was 4.2 points (the individual rating average ranges from 2.0 to 5.0 points).

*Individual Responses—Policy Preferences Index (PPI)*

The respondents were instructed to rate their level of support for various domestic climate-mitigation policies (Table 5.7). This 5-item composite policy preferences index is measured on a 5-point Likert scale (a higher score indicates a higher level of support). The result reveals that the majority of the respondents (over 85%) supported policies such as shifting government subsidies to less polluting industries (item 1), regulating GHG emissions with mandated targets and timelines (item 2), and a reforestation program (item 4). A total of 75.4% supported financial instruments to encourage GHG emission reductions (item 3). While only 37.2% endorsed the use of nuclear power as an alternative energy source (item 5), 43.5% took a neutral position.

The second way to measure level of support is via the rating average of each item and the composite index. Among five policies, the respondents showed a high level of support for a reforestation program (rating average 4.6 points), an industrial structure adjustment policy that shifts the government subsidy to less polluting industries (4.3 points), and a mandatory GHG emission regulation (4.3 points). They also preferred the financial instruments (4.1 points). The respondents expressed the least amount of support for the nuclear power alternative policy (3.3 points) (see the last column in Table 5.7).

The result of the item-analysis test of the PPI obtains a satisfactory internal consistency (Cronbach's  $\alpha=0.55$ ) with item-total correlations ranging between 0.15 and 0.48. The result suggests that omitting the last item (nuclear power alternative)

enhances the validity of the index (Cronbach's alpha increases to 0.63). Hence, the revised index uses the rest of the four items for further analysis. The revised four-item PPI result shows that the respondents supported these policies with an average rating of 4.3 points (the individual rating ranges between 3.0 and 5.0 points).

**Table 5.7** Percentage Distribution and Rating Average of the Policy Preferences Index (n=285).

	S* 5	SS 4	N 3	SO 2	O 1	DK m	Rating Ave.
1. Encourage the development of less pollution and energy intensive industries and discourage the development of high pollution and energy intensive industries by shifting government subsidy programs	<b>40.4</b>	<b>48.1</b>	10.2	0.7	0.7	0.0	<b>4.3</b>
2. Implement a law regulating greenhouse gasses as air pollutants and requiring industries to reduce their emissions in accordance with legally mandated targets and timelines	<b>39.3</b>	<b>48.4</b>	10.9	0.7	0.0	0.7	<b>4.3</b>
3. Use taxes and other financial incentives to encourage reductions in greenhouse gas emissions	<b>36.8</b>	<b>38.6</b>	20.7	3.2	0.4	0.4	<b>4.1</b>
4. Encourage the planting of trees	<b>64.9</b>	<b>28.8</b>	4.6	1.8	0.0	0.0	<b>4.6</b>
5. Support the use of nuclear power as an alternative source of energy	<b>13.7</b>	<b>23.5</b>	43.5	12.3	6.0	1.1	<b>3.3</b>

\*S: Support, SS: Somewhat Support, N: Neutral, SO: Somewhat Oppose, O: Oppose, DK: Do not Know

\*\* The scoring for each level was recorded from 1 to 5 points. DK was recorded as a missing value.

### Summary of Findings

This larger-scale web-based survey aimed to investigate Taiwanese university students' overall concern about climate change (i.e., attitudes, scientific knowledge, behavioral intentions, and policy preferences) and to explore the hypothetical relationships among these constituent elements. The results find that Taiwanese young adults endorsed the

reality of global climate change and demonstrated a medium level of concern. Although most of them recognized environmental protection as a prioritized policy, they tended to give more priority attention to local environmental issues.

Scientists were the primary source of information through which the majority of the respondents would turn to resolve doubts with a medium level of trust. In addition, a majority agreed that anthropogenic forces were responsible for global climate change and the concept of common but differentiated responsibilities. The results of the survey also implied that while Taiwanese university students recognized that climate change may affect them personally and that they could take some actions, some of them do not think their daily activities contribute to the problem.

While the level of scientific knowledge of Taiwanese university students was satisfactory (with an average of 78 out of 100 points), they had a limited understanding of detailed issues pertaining to global climate change and they tended to confuse global climate change with stratospheric ozone depletion. Moreover, the analysis finds that Taiwanese university students asserted that the country should begin to reduce its GHG emissions because of an ethical obligation. In addition, they showed a fairly high level of willingness to change personal behaviors to combat climate change and they generally supported climate-mitigation policies, except the nuclear power option.

### **5.2.5 Concluding Remarks**

Three constituent studies (i.e., IA focus-group workshop, the pre- and post-survey, and the web-based survey) aimed to examine Taiwanese university students' general concerns about global climate change (i.e., attitudes, scientific knowledge, behavioral intentions, and policy preferences) and to explore whether the experimental IA focus groups with the

integration of experts and citizens effectively enhanced the overall level of scientific understanding and policy making.

The participants received information from the invited experts, as well as from fellow participants through interactive group discussions. A comparative analysis found that the participatory mechanism effectively enhanced some of the participants' viewpoints, such as the level of familiarity, political priorities, and perception of personal relevance, climate-policy support, and so forth. Most importantly, the respondents' factual scientific knowledge and uncertainty improved significantly even though their basic understanding of causes, impacts, and mitigation actions did not change.

In addition, the IA focus-group participants contributed significant lay perspectives including some new ideas and concerns about compliance with related climate policies. Moreover, these three studies in combination provide valuable insights on Taiwanese young adults' viewpoints about global climate change in terms of personal attitude, scientific knowledge, and individual responses. Based on the quantitative and qualitative information collected from these three interrelated studies, a comprehensive analysis of the public understanding of climate science (i.e., constituent elements and interrelationships) is discussed in the subsequent section.

### **5.3 Analysis: Constituent Elements and the Relationships**

#### **5.3.1 Introduction**

As discussed in Chapter 2, key elements of the public understanding of climate science include attitudes, scientific knowledge, and behavioral intentions. By contrasting the research findings of three constituent studies and comparing the results with the

preceding literature, this section primarily provides an integrated analysis of each of the three constituent elements of the public understanding of climate science and on the relationships among these elements. The quantitative data collected in two surveys are analyzed and supplemented with qualitative dialogues from the IA focus groups.

Before doing any analysis and or making any statistical inferences, it is worth mentioning that the research subjects are a group of young adults with a relatively high education level (mainly university students). In addition, due to the nature of voluntary involvement (self-selected in the studies), these respondents are probably interested in the issue of global climate change to a higher degree than their peers.

Subsection 5.3.2 analyzes Taiwanese university students' attitudes toward climate change from a variety of perspectives (e.g., problem recognition). Subsection 5.3.3 examines the level of scientific knowledge of climate change in terms of causes, adverse impacts, mitigation strategies, and scientific facts. Subsection 5.3.4 explores respondents' personal responses to the problem in terms of behavioral intentions and policy preferences. Subsection 5.3.5 analyzes the hypothetical relationships among these elements and the effects of demographic factors (i.e., gender and academic majors) on the public understanding of climate science. Subsection 5.3.6 discusses the effectiveness of the experimental IA focus groups. Subsection 5.2.7 provides a few concluding remarks.

### **5.3.2 Attitudes**

#### *General Awareness*

Hsu (2006) maintains that most Taiwanese college students first heard about the greenhouse effect and climate change in the mid-2000s. This level of familiarity was similar to the American public's awareness of the problem in 2006 (Nisbet & Myers,

2007). While most Taiwanese university students may have been exposed to basic climate-change information (i.e., they heard about the issue), this study suggests that they are not very confident in their understanding of various climate-related terms and policies.

On the basis of self-evaluated awareness in the pre-test of the IA focus groups, the respondents (n=18) displayed a medium level of familiarity with three commonly interchangeable terms (i.e., global climate change, global warming, and the greenhouse effect). By comparison, they were even less familiar with two associated policies (i.e., the Kyoto Protocol and the Taiwanese Greenhouse Gasses Reduction Bill (Draft)). Even though these results were assessed by the respondents themselves, the findings can serve as a reference to further investigate the level of their understanding of global climate change.

### *Problem Recognition*

Kronsnick and colleagues (2006) argue that people who consider climate change to be a serious problem and support climate policies are the ones who believe in human-induced global warming and its adverse impacts with certainty. The results of the three studies find that most Taiwanese young adults have become convinced that global climate change is real and has already become manifested. This perception is consistent with the American public's perception in 2008 (Nisbet & Myers, 2007; Gallup, 2008).

However, while Taiwanese university students and the American public shared a similar level of regard for the reality of global climate change, they showed quite different viewpoints about the effects of anthropogenic forces. Approximately half of the American public (and 60% of the British public) doubt that global warming is caused by

human activities. The results of the three studies suggest that most Taiwanese university students (over 85%) believed that human activities are the main driving forces behind global climate change.

In addition, Krosnick et al. (2006) argue that conviction in the existence of human-induced global warming positively influences people taking climate-protection actions. This perception appears to be a nonessential component for Taiwanese university students. The dialogues of the IA focus group suggest that the participants did not think that it is necessary to prove the corresponding relationship between anthropogenic forces and global climate change. They argue that humans need to take responsibility to resolve the problem regardless of whether climate change is driven by human activities.

#### *Trust in Scientists*

Nisbet and Myers (2007) argue that trust in scientists is a factor in public perception of scientific evidence pertaining to global warming. While only 32% of Americans trust scientists on the issue of the environment completely or a lot, Taiwanese university students displayed a higher level of trust in scientists. A total of 60.7% of the respondents trusted scientists on the issue of global climate change completely or mostly. In addition, scientists and experts are considered to be the most reliable source of information for Taiwanese university students compared to other sources (e.g., environmental activists and journalists).

#### *Risk Perception and Personal Relevancy*

While Americans have begun to recognize that global warming has already begun to occur, less than half of them worried about the problem and proposed immediate and

drastic remedial actions (Gallup, 2008). This attitude possibly resulted from the perception that they do not think that global warming will threaten them in their lifetime. In contrast to Americans who consider global warming as somewhat distant from them, most Taiwanese university students were concerned about global climate change and believed that the problem could impact them personally in their lifetime.

In addition, the studies investigated respondents' perceived relevancy in terms of their contribution to the problem and potential actions from young people. Interestingly, fewer Taiwanese university students acknowledged that their activities cause global climate change. This denial attitude (i.e., denial of responsibility) is an example of the tragedy-of-the-commons interpretation (i.e., I am not the main cause of this problem and some other people cause the problem as well) (Stoll-Kleemann et al., 2001).

One contradictory perspective about the efficacy of a young person was observed. Most Taiwanese university students expressed that climate change is beyond the control of a young person, but they also agreed that there is still something a young person can contribute to resolve the problem. This perception is consistent with the findings of the 2008 UNEP survey in which young respondents believed that they could make a difference on the issue (UNEP, 2008a). Even though these young adults feel the same sense of helplessness and powerlessness that may give rise to a psychological barrier to engage with efforts to ameliorate climate change (Lorenzoni et al., 2007; Stoll-Kleemann et al., 2001), they somehow displayed a positive willingness to actively prevent it.

### *Blame and Responsibility*

While the principle of common but differentiated responsibilities has been asserted in many international environmental treaties, few studies have investigated what the public

thinks about the concept. Ironically, the idea of differentiating responsibilities between industrialized countries and developing countries has been manipulated by some politicians as an unfair rationale that justifies inaction. Given the fact that Taiwan is a newly-industrialized country (in the transition from a developing to industrialized nation), this doctoral research intends to explore lay perspectives about this controversial concept.

This investigation uncovers some interesting perspectives. More than half of the respondents in the online survey concurred that industrialized countries are primarily responsible for climate change and they should exert more effort to address the problem than developing countries. Approximately one-fifth of the respondents (20.4%) neither agreed nor disagreed with the concept. It would be interesting for future research to explore how the general public perceives Taiwan's international economic status: as an industrialized or developing country?

Some of the IA focus-group participants based their argument on the technological and financial capacity of industrialized countries. In addition to agreement with the notion of common but differentiated responsibilities, they argued that the responsibility of each country should be proportional in terms of its aggregated GHG emissions (including historical emissions). Moreover, due to ongoing process of globalization, they raised the issue of responsibility of multinational corporations—they thought the GHG emissions of these companies should belong to the country where its headquarters is registered rather than where its manufacturing activities take place.

### *Political Priority*

Compared with other environmental issues, global warming receives a relatively lower level of concern from Americans (Nisbet & Myers, 2007; Pew Research Center, 2008). A

similar situation has been observed in the United Kingdom where the public places domestic issues as higher priorities than climate change (Norton & Leaman, 2004; Kirby, 2004; Poortinga & Pidgeon, 2003). This doctoral research finds that Taiwanese university students had a tendency to select environmental issues as prioritized public policies for the government to take immediate actions.

In addition, when asked about their preferences in an abstract scenario regarding the potential trade-offs between economic development and environmental protection, most of the respondents (93.3%) favored the environment over the economy. These data are higher than the result collected in the 2001 TSCS which revealed an approximate split perception (46% for the economy and 41% for the environment) (Tu, 2004). The high level of environmental concern observed in the sample population is possibly a result of the chosen sampling technique—potential participants self-selected in this doctoral research because the invitation message tended to attract people with interests in environmental matters.

Although most Taiwanese university students place environmental protection as a prioritized policy, they do not view global climate change as the top issue and instead are likely to pay more attention to local environmental issues (e.g., air pollution and ecosystem destruction) (this is similar to the American and British public). A detailed analysis of individual attitudes with respect to personal behavior, the Kyoto Protocol, and domestic climate policies are discussed in Subsection 5.3.4.

In brief, Taiwanese university students display a pro-environmental attitude in terms of political priority and potential conflicts with economic growth, but this perception does not necessarily relate to global climate change in comparison to other

environmental issues. Nonetheless, these young adults show an attitude of protecting the climate: they acknowledge the reality of human-induced climate change; they are concerned about the adverse impacts of climate change; they recognize the additional responsibilities of industrialized countries. Moreover, they trust scientists with respect to the issue of climate change. Even though Taiwanese university students are aware that climate change is personally relevant to them to some degree, some of them do not think their daily activities contribute to the problem. Interestingly, despite the helpless feeling of an individual's power, they still believe that there is something a young person can contribute.

### **5.3.3 Scientific Knowledge**

#### *A Limited Scientific Understanding*

As discussed in Subsection 2.3.4, in contrast to an increasing level of awareness of global climate change, the public's scientific knowledge of climate change is inconsistent—they recognize the anthropogenic causes better than the resultant impacts and possible interventions. A number of studies have found that the majority of respondents (e.g., the American public, British and Taiwanese higher education students) could correctly recognize the use of fossil fuels as a cause of climate change in the mid 2000s (Nisbet & Myers, 2007; Spellman et al., 2003; Reiner et al., 2006; Hsu, 2006).

The majority of Taiwanese university students was able to correctly identify several direct causes (e.g., industrial GHG emissions, deforestation). The only exception was their failure to distinguish the problem of global climate change from the problem of stratospheric ozone depletion (a common misconception that will be discussed later in this subsection). This research finds that Taiwanese university students had a better level

of understanding of the adverse impacts of climate change (e.g., precipitation and temperature variation, sea-level rise) and had a poorer level of knowledge about mitigation strategies (e.g., public transportation, carbon capture and storage technology).

Based on the survey data collected in the IA focus groups, while Taiwanese university students have a basic scientific knowledge of global climate change, they seem ill-informed about some advanced scientific factual knowledge, such as scientific observation and future projections of the consequences of global climate change. For example, these young adults recognize increasing temperature and rising sea-level as potential impacts of the growing accumulation of GHGs, but they did not know the exact extent to which the temperature and the sea-level have increased and may increase in the future. Moreover, they also display a limited understanding of specific technologies and information (i.e., carbon capture and storage, geo-engineering technologies, the exact goals of the Kyoto Protocol, Taiwan's energy use and CO<sub>2</sub> emissions per capita)

### *Scientific Misunderstanding*

The results of this doctoral research suggest that Taiwanese university students have a tendency to confuse global climate change with stratospheric ozone depletion. They thought that ozone depletion causes global climate change. This misperception is consistent with the long-standing findings observed for the American public (Bostrom et al., 1994; Read et al., 1994; Nisbet & Myers, 2007) and with the findings collected in Taiwan as well (TEPA, 2006; Hsu, 2006).

In addition to this common point of confusion, the results of the pre- and post-surveys found that Taiwanese university students mistakenly thought that if the global concentration of all greenhouse gases and aerosols had been kept constant at year

2000 levels, further warming could have been stopped. This misunderstanding is similar to the MIT studies by Stermann and Sweeney (2002; 2007) who found that people (even MIT students) tend to misguidedly believe that if GHG emissions decrease, the atmospheric GHG concentrations and the global average temperature would soon decrease. The global climate system cannot be reversed that quickly. This misconception may lead to a wait-and-see mentality which then delays policy responses.

In brief, environmental attitude researchers argue that an individual's knowledge and cognitive expression is an indicator of his or her behaviors (Ajzen & Fishbein, 1980). Bord et al. (2000) verifies the theory with the finding that a correct understanding of the causes of climate change is a significant determinant of climate protection behavioral intentions. However, few academic studies have been conducted to explore the public's complete scientific understanding of global climate change. In investigating the extent to which Taiwanese young adults understand climate change (i.e., physical and policy scientific knowledge) and the depth of their knowledge (i.e., knowledge of scientific facts), this doctoral research finds that their level of scientific knowledge is extensive in basic science, but not in terms of detailed and specific scientific facts.

#### **5.3.4 Behavioral Intentions**

##### *Public Support for GHG Emission Reduction Policies*

A majority of Americans support the Kyoto Protocol and thinks that the United States should reduce its GHG emissions regardless of the action of other countries (Leiserowitz, 2006; Nisbet & Myers, 2007). Additionally, young people across five countries thought world leaders should do whatever it takes to combat climate change (UNEP, 2008a). This high level of desire for the government to take action was observed in Taiwan as well.

This doctoral research finds that despite the fact that Taiwan is not a signatory to the UNFCCC or the Kyoto Protocol, Taiwanese university students assert with nearly unanimous support that Taiwan should begin to reduce its GHG emissions.

As to the public's attitude toward various domestic climate policies, a couple of public polls conducted find that a majority of Americans prefer GHG emission reduction policies that target industries rather than households and consumers (Leiserowitz, 2006; Nisbet & Myers, 2007). Their tendency to oppose increased energy taxes (i.e., electricity and gasoline) on consumers suggests that Americans expect the problem to be solved by the government or industries without changes in their personal behaviors (Leiserowitz, 2006). This mentality can be explained as two individual barriers to engage with climate change: 1) externalizing responsibility and blame on governments and industries and 2) reluctance to change lifestyles (also see Table 2.1) (Lorenzoni et al., 2007).

This case study reports a somewhat different but nonetheless interesting finding. Taiwanese university students similarly support a variety of domestic climate mitigation policies with the exception of a nuclear energy alternative plan. However, despite the fact that the industrial sector comprises the majority of CO<sub>2</sub> emissions in Taiwan, these young adults thought that household and consumers should also bear some responsibility. In other words, they did not pinpoint blame on industries and shed their own responsibility.

#### *Public Perception of Taking Personal Actions*

Bord et al. (2000) found that Americans were willing to change some, but not all, behaviors to combat climate change. For example, they were more willing to purchase an energy-efficient car and to install more insulation in their houses than to drive less and use less air conditioning and heat. In other words, while consumption-orientated

Americans have no problems purchasing green products, they show difficulties in taking behaviors that are seen as degrading their quality of life. This example can be explained perfectly by one individual barrier (i.e., reluctance to change lifestyles) and one social barrier (i.e., pressure of social norms) (Lorenzoni et al., 2007). It is difficult for the public to overcome these barriers and to shift to more sustainable lifestyles because consumerism and car ownership have been embedded as parts of American culture and lifestyle.

In contrast, Taiwanese university students were more willing to conserve energy and to drive their personal vehicles less and use public transportation. However, they were not inclined to pay more for renewable energy and to purchase more energy efficient household appliances. Unlike the United States where personal vehicles are major transportation tools, the public transportation system is better established in Taiwan so people are likely to change their driving habits. However, another possible explanation is the unique nature of the youth population—a group of people who are in a relatively low economic status and have less latitude in their consumption choices.

In brief, even though Taiwan is a not signatory to the UNFCCC or the Kyoto Protocol, Taiwanese university students asserted that Taiwan should begin to reduce its GHG emissions based on a sense of ethical obligation. In addition, these young adults are willing to change a variety of personal behaviors to combat climate change (except engage in actions associated with green consumption). Moreover, they support numerous climate-mitigation policies. The only policy Taiwanese university students are reluctant to endorse is the use of nuclear power as an alternative energy source. This perception may be the result of the long-lasting anti-nuclear movement in Taiwan.

Patchen (2006) argues that the public tends to take actions to combat climate change based on two justifications: utilitarian conceptions (i.e., the rational judgment of the net benefit) and emotional concern (i.e., the fear feeling of being threatened by climate-change impacts). Despite socio-cultural factors, people may heuristically measure the cost and benefit of certain actions and take the one with the greater net benefits. For example, increased gasoline and electricity prices may induce people to use public transportation or to save household energy.

Unlike Americans who view global climate change as psychologically distant and as something that is unlikely to threaten them in their lifetime, Taiwanese university students believe that the problem would affect them personally. This sense of risk and urgency may also enable people to take potential actions that could lessen the severity of the problem. This case study of Taiwan suggests a third justification: ethical concern. These young adults exhibited a strong ethical attitude—ecological citizenship—that drives their willingness to take climate protection behaviors. This observation will be discussed further in Chapter 6.

### **5.3.5 Relationships among Constituent Elements**

In addition to the first research objective (i.e., to examine general concern and scientific understanding of climate change of Taiwanese youth) that is introduced in Subsections 5.3.2 to 5.3.4, the second objective is to investigate the interrelationships between respondents' scientific knowledge and their behavioral intentions and policy preferences. Attitude-behavior theory claims that a person's actions are influenced by external social norms and internal belief system (e.g., emotion, knowledge, and behavioral intentions) (Ajzen & Fishbein, 1980; Dunlap & Jones, 2002).

As reviewed in Chapter 2, a number of studies have examined how various factors influence these constituent elements. Nisbet and Myers (2007) found that trust in scientists influences the perception of scientific evidence pertaining to global warming. Krosnick et al. (2006) argue that knowledge levels affect a personal certainty and seriousness of judgment of global warming and that the belief of human-induced global warming is a determinant of personal behaviors to tackle climate change. Bord et al. (2000) argue that a correct understanding of the causes of climate change is a significant determinant of climate protection behavioral intentions.

Therefore, this doctoral research analyzes the hypothetical relationships among these three constituent elements of the public understanding of climate science including seven variables. First, several ANOVA were administered to investigate the effect of two demographic variables (i.e., gender and academic majors) on these dependent variables (i.e., general concern, trust in scientists, belief in human force, personal relevancy, scientific knowledge, personal behaviors, policy preferences).

The results of these ANOVA tests reveal that gender and academic major do not have a significant impact on these variables. It means that the differences in these young adults' responses are not statistically significant because of gender and academic major. The only exception is the effect of gender on personal behaviors. The results show that female students were significantly more willing to assume responsibility for personal behaviors with an average score of 4.3 points than male students were with an average score of 4.1 points ( $p=0.007$ ).

Furthermore, Pearson correlation analysis was conducted to determine the degree of the linear relationships between two variables among these seven variables (Table

5.8).<sup>71</sup> A total of eight statistically significant good relationships are found ( $r > 0.3$  and  $p < 0.01$ ) (Figure 5.11). First, reviewing the relationship between variables in the attitude element, it is found that there are three positive relationships between the concern level and trust in scientists ( $r = 0.366$ ), between the concern level and personal relevancy ( $r = 0.374$ ), and between the belief of human forces and personal relevancy ( $r = 0.397$ ).

In other words, people who trust scientists to a greater degree are possibly more concerned about the adverse impacts of global climate change. In addition, people who are concerned with climate change tend to think of the problem as more relevant to themselves in terms of individual causes, impacts, and actions. Moreover, people who believe in anthropogenic forces of climate change with more certainty are most likely to think of the problem as having high personal relevancy.

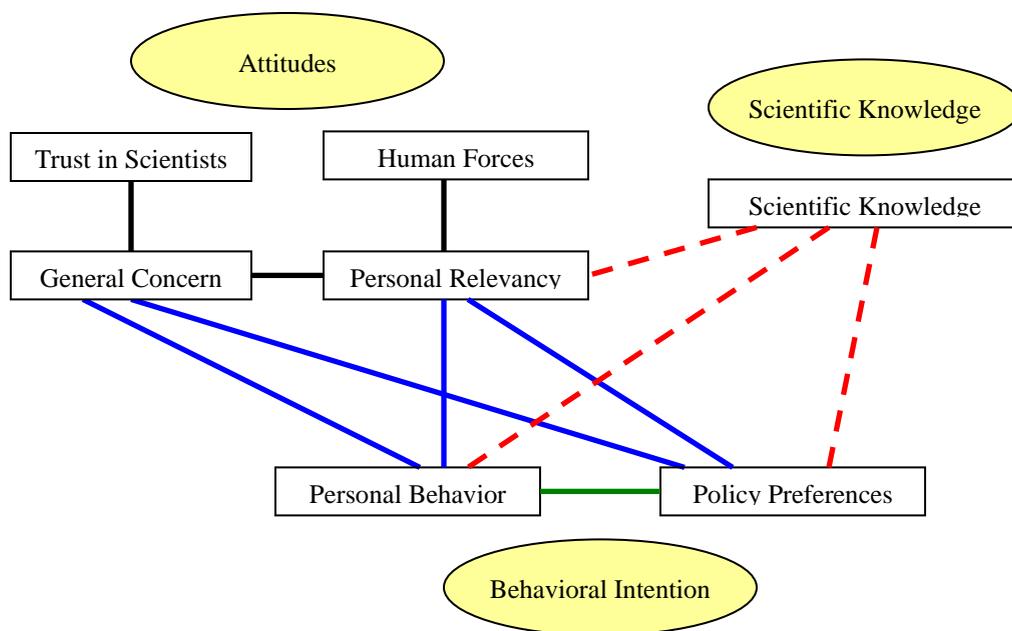
**Table 5.8** Pearson Correlations and P Value for Numerous Variables (n=285)

		Concern Level	Trust in Scientist	Human Force	Personal Relevancy	Scientific Knowledge	Personal Behavior
Attitude	Trust in Scientist	<b>0.366</b> <b>0.000</b>					
	Human Force	0.049 0.406	<i>0.224</i> <i>0.000</i>				
	Personal Relevancy	<b>0.374</b> <b>0.000</b>	<i>0.222</i> <i>0.000</i>	<b>0.397</b> <b>0.000</b>			
	Scientific Knowledge	0.089 0.136	-0.014 0.821	0.016 0.783	<i>0.193</i> <i>0.001</i>		
Behavioral Intention	Personal Behavior	<b>0.414</b> <b>0.000</b>	<i>0.169</i> <i>0.004</i>	<i>0.167</i> <i>0.005</i>	<b>0.336</b> <b>0.000</b>	<i>0.172</i> <i>0.004</i>	
	Policy Preferences	<b>0.337</b> <b>0.000</b>	<i>0.197</i> <i>0.001</i>	<i>0.223</i> <i>0.000</i>	<b>0.388</b> <b>0.000</b>	<i>0.186</i> <i>0.002</i>	<b>0.455</b> <b>0.000</b>

Cell Contents: Pearson correlation coefficient ( $r$ )  
P-Value

Note: The value in bold indicates a significantly fairly good correlation ( $r > 0.3$  and  $p < 0.01$ ). The value in italic indicates a significantly weak correlation ( $r < 0.3$  and  $p < 0.01$ ).

<sup>71</sup> Pearson correlation coefficient is denoted with the lowercase letter  $r$ . The value of correlation coefficient ranges from -1 to 1. A larger value of  $r$  indicates a larger degree of relationship. In addition, a small  $p$  value (less than alpha level) indicates that the test is statistically significant at a significance level (0.01 is a commonly used alpha level).



**Figure 5.11** Relationships between variables of three constituent elements.

Second, reviewing the relationship between variables in the elements of attitudes and behavioral intentions, it is found that the concern level and personal relevancy are two key determinants of personal behaviors and policy preferences. People who are concerned about climate change tend to display higher willingness to take climate protection behaviors ( $r=0.414$ ) and to endorse climate policies ( $r=0.337$ ). In addition, people who think that climate change is relevant to themselves are more willing to take climate protection actions ( $r=0.336$ ) and to support climate policies ( $r=0.388$ ).

Third, a strong relationship between personal behaviors and policy preferences is found. People who are more willing to take climate-protection actions are more likely to support climate policies ( $r=0.455$ ).

Finally, in addition to these eight strong relationships, the level of scientific knowledge has statistically significant but weak relationships with personal relevancy and

behavioral intentions (see the dashed lines in Figure 5.11). People who are more scientifically knowledgeable tend to view global climate change as relevant to themselves ( $r=0.193$ ), to take climate protection actions ( $r=0.172$ ), and to support climate policies ( $r=0.186$ ).

In brief, the statistical ANOVA analyses find that gender (i.e., male and female) and academic majors (i.e., science and non-science) do not have a significant effect on the attitudes, knowledge, and behavioral intentions of young adults in Taiwan. Furthermore, the correlation analyses suggest that the level of concern and the perceived relevancy about global climate change are two factors that determine a person's behavior and policy preferences. In contrast, the level of scientific knowledge has relatively weak linear relationships with a person's behavioral intentions.

### **5.3.6 Effectiveness of the IA Focus Groups**

As highlighted in Section 4.2, the third research objective is to assess the effectiveness of an experimental participatory exercise in enhancing the public's scientific understanding and in formulating climate policies (whether the level of support for climate policies increases). While the IA focus groups engaged scientists and citizens (i.e., young adults in this case) in deliberating some policy issues of climate change, it is of particular interest to observe the dynamic relationship among these two actors and how they cooperatively contributed to enhancing the quality of climate policies.

On one hand, one key role of scientists in the political arena is as communicators that translate elite scientific knowledge to plain language for lay audiences (Susskind, 1994; Hannigan, 1995). On the other hand, it is also essential for the public to understand science (e.g., Haldane, 1939; Durant et al., 1989). The integration of scientists into

citizens' deliberation processes is generally expected to enhance the quality of both the lay public's knowledge capability and the resultant policy decisions.

### *Building Intelligent Capability*

The pre-survey found that prior to the IA focus groups the participants displayed a fair level of basic scientific knowledge of global climate change (i.e., causes, impacts, and mitigation strategies) and an unsatisfactory level of advanced scientific knowledge (e.g., the scientific phenomenon, scientific facts). This inadequate knowledge level may be the reason why some of the participants expressed a need to acquire information from the event. The results of the pre- and post-surveys and the IA focus groups suggest that this experimental participatory activity indeed helped the participants in bridging the gap of knowledge insufficiency to some degree.

Although the participants' understandings of the causes, consequences, and mitigation actions of climate change were not significantly changed, the level of factual scientific knowledge and the level of uncertainty did improve significantly after the IA focus groups (see Figure 5.2). In other words, these participants had a better understanding of the information they had no prior knowledge of, but their understanding remained unchanged with respect to the information they had previously acquired.

In addition to the assistance of the invited scientific experts, the participants could receive some potentially valuable information from each other. During interactive group discussions, some knowledgeable participants were able to answer questions raised by their colleagues. Although these two experts were brought in to provide key scientific information (one-way communication rather than a two-way interaction), the participants relied on these scientists' appraisal to a very high degree. While advancing their own

opinions, participants often cited information that they had gleaned from the experts.

In brief, the participatory event with an integration of scientists did effectively enhance the public's scientific knowledge in some aspects. The result suggests that while people have developed some common opinions regarding global climate change (e.g., fossil fuels are causes of climate change, the increasing temperature is an adverse impact, saving energy is a mitigation solution), their basic understanding did not change easily and was not subject to effortless improvement. What may change significantly is the information they do not know. Thus, it is interesting for researchers involved in work on the public understanding of science to study two transitions: 1) the transition from total ignorance to satisfactory literacy and 2) the transition from satisfactory literacy to outstanding levels.

#### *Enhancing the Quality of Policy Decisions*

One way to review whether the IA focus groups enhanced the quality of policy decisions is through the level of public compliance—a more highly supported policy would probably lead to a more effectively implemented policy. The result of the pre- and post-surveys finds that despite the fact that the respondents already expressed a relatively high level of support for several potential mitigation initiatives in the pre-test survey, their support for six climate policies still increased after the IA focus-group workshop. The only exception to this general pattern was the decreased support for the alternative nuclear power policy. In addition, policy makers in Taiwan should be aware of the unpopularity of the nuclear power option.

The other way to evaluate the quality of policy decisions is through the valuable opinions collected from the participants. During the IA focus-group sessions, in addition

to some general issues (e.g., the national commitment, the principle of common but differentiated responsibilities), two domestic climate policies were discussed. Through group interaction, interesting comments were raised and different perspectives were exchanged. For example, the participants discussed numerous new ideas including the calculation of carbon-emission allowances for multinational corporations, the distribution of responsibility based on the retroactive liability principle, and the carbon labeling and certification of consumption goods. Moreover, these young adults provided some lay perspectives on the difficulties of compliance with the voluntary program on conserving energy and reducing carbon emissions. These comments represent valuable feedback for policy makers when drafting or implementing policies.

### **5.3.7 Concluding Remarks**

From an individual psychological perspective, this doctoral research into the public understanding of climate science includes three elements: attitude, scientific knowledge, and behavioral intention. The study finds that Taiwanese university students recognize the existence of human-induced climate change and that they are aware that the problem is relevant to them to some degree. Although some respondents did not think their daily activities contributed to the problem and doubt the efficacy of an individual's action, their strong ethical attitude made them believe that a young person can still contribute something.

In contrast to pro-climate protection attitudes, this doctoral research suggests that Taiwanese university students' level of scientific knowledge pertaining to global climate change is extensive in basic science, but not detailed in specific scientific facts. In terms of individual behavioral intentions, these young adults were willing to endorse a variety

of actions and mitigation policies to combat climate change in general. The only policy that they were reluctant to support is the use of nuclear power as an alternative energy source.

Furthermore, correlation analyses were conducted to explore the interrelationships among these three elements. The result suggests that level of concern and perceived relevancy about climate change are two key determinants of a person's behavior and policy preferences. In contrast, the level of scientific knowledge has relatively weak linear relationship with a person's behavioral intention. Finally, this doctoral research also finds that the experimental IA focus groups with the integration of scientists and citizens effectively enhanced these young participants' scientific knowledge and support for climate policies. Moreover, valuable lay perspectives were shared in contributing to the quality of climate policies.

#### **5.4 Summary**

The key inquiry in this doctoral research has been whether public understanding of climate-change science is a necessary prerequisite for effective policy making. To address this question effectively, three constituent studies (i.e., IA focus-group workshop, the pre- and post-survey, and the web-based survey) were designed in combination to achieve three objectives: 1) to examine Taiwanese university students' general concerns about global climate change (i.e., attitudes, scientific knowledge, and behavioral intentions); 2) to investigate the interrelationship among these three elements; 3) to assess the effectiveness of the experimental IA focus groups in enhancing an individual's scientific understanding and policy making.

First, these studies find that while Taiwanese university students have a tendency to maintain attitudes and behavioral intentions that could mitigate climate change in general, their level of scientific knowledge pertaining to global climate change is extensive in basic knowledge (i.e., causes, adverse impacts, and mitigation strategies), but limited in specific scientific facts.

Second, the results of the correlation analyses suggest that the attitudinal element (the level of concern and personal relevancy in specific) is a more significant factor than the element of scientific knowledge in determining a person's behavior and policy preferences.

Finally, the experimental IA focus groups effectively improved young participants' scientific understanding (factual knowledge in specific) and support for climate policies. Moreover, the participatory exercise provided an opportunity for policy makers to collect young adults' valuable perspectives for the quality and implementation of climate policies.

In summary, these findings raise two interesting issues worthy of discussion (see the detailed discussion in Chapter 6). The first observation is that Taiwanese university students display a strong ethical perspective: ecological citizenship. The respondents in this study asserted that Taiwan needs to reduce its GHG emission based on moral grounds. Moreover, although most of the IA focus-group participants recognized human influences on the climate system, they asserted that humans need to resolve the problem regardless of whether climate change is driven by human activities. Furthermore, regardless of whether the industrial sector comprises the majority of CO<sub>2</sub> emissions in Taiwan, these young adults maintained that the public should also bear responsibility. This ecological

citizenship perspective may be influenced by distinctive Taiwanese national character and the eastern culture.

The second focal issue worthy of exploration is public understanding of science for the issue of global climate change. Compared to numerous studies of public perception of climate change, few efforts have been made to investigate people's comprehensive scientific knowledge. Even though this doctoral research finds that scientific knowledge may not be as influential as attitude in determining an individual's behaviors, numerous questions remain to be investigated, such as the measurement of scientific literacy for specific issues, the integration of scientists and citizens, and so forth. While this doctoral research presents an empirical case study of Taiwan, the following Chapter 6 will discuss both issues in detail and conclude with important finalizing remarks.

## CHAPTER 6

### DISCUSSION AND CONCLUSION

#### 6.1 Overview

To enhance contemporary understanding of the social dimensions of global climate change, this interdisciplinary doctoral research, titled *The Public Understanding of Climate Change: A Case Study of Taiwanese Youth*, seeks to explore the relationships among science, the public, and politics. By conducting empirical studies (i.e., IA focus groups and survey studies), this study investigated the extent to which young citizens understand climate change in terms of their attitudes, scientific knowledge, and behavioral intentions on an individual level and assessed interrelationships among these elements.

The previous chapters in this dissertation have described the background of the problem (Chapter 1), the research rationale (Chapter 2), the contextual background of the case study (Chapter 3), the research methods (Chapter 4), and the research results (Chapter 5). This study presents valuable insights and uncovers some interesting issues. This final chapter considers two lines of inquiry and concludes with several remarks on this research. Section 6.2 first discusses possible factors that drive the ethical viewpoints of the Taiwanese youth that participated in this study and then considers several issues related to studying the public understanding of science from the standpoint of climate change. Section 6.3 concludes this dissertation with summaries of the findings, contributions, and recommendations for future research. Finally, Section 6.4 summarizes this doctoral research with some concluding remarks.

## 6.2 Discussion

### 6.2.1 Introduction

Chapter 5 reports the results of the empirical study of this dissertation in terms of each of the constituent elements of the public understanding of climate change science (i.e., attitudes, scientific knowledge, and behavioral intentions) and the interrelationships among these three facets. Two of the most prominent findings that were observed during the course of this investigation include 1) Taiwanese young adults display a strong sense of ecological citizenship and 2) scientific knowledge is not overwhelmingly influential in determining individual behavioral intentions.

It is particularly interesting to explore the underlying reasons behind these two observations. First, why did Taiwanese young adults evince a strong sense of ecological citizenship? Second, the weak correlation between scientific knowledge and individual behavioral intentions found in this study suggests that scientific knowledge was unlikely a “necessary prerequisite” for effective policy making. The question then turns to what this finding suggests for research on the public understanding of science with respect to scientific literacy and the relationship between experts and society for climate change.

Based on the contextual information provided in Chapter 2 and 3, this section discusses the above two inquiries in depth. Subsection 6.2.2 describes possible social, political, and cultural factors that influence the attitudes of Taiwanese young adults about both Taiwan’s and their own moral obligations to mitigate global climate change. Subsection 6.2.3 presents several interesting observations pertaining to research on the public understanding of science for a specific scientific issue like global climate change. The last subsection concludes with some insights that emanate out of this discussion.

### 6.2.2 Ecological Citizenship in Taiwanese Youth

The results of the three studies suggest that Taiwanese youth have a strong sense of ecological citizenship and these sensibilities can be attributed to the following factors.<sup>72</sup>

First, because its current diplomatic status excludes it from participating in official negotiations around international climate treaties, Taiwan is technically not obligated to reduce its GHG emissions. Even though its international commitment and participation is neglected, a near unanimity of Taiwanese youth thought that Taiwan should begin to address the problem of its relatively high releases. While the Taiwanese government positions itself as an active member of the global community that needs to fulfill its responsibilities with respect to protection of the global environment (TEPA, 2002), the young respondents in the studies reported here also justified their position on an ethical perspective—the country, as a member of the global community, does not have the right to destroy the environment.

Second, while most Taiwanese youth recognize that humans have substantially changed the chemical composition of the atmosphere, the results of the IA focus groups suggested that they did not think that the unambiguous verification of the corresponding relationship between anthropogenic forces and global climate change was necessary. The respondents instead argued that humans need to take responsibility to address the problem regardless of whether climate change is driven by human activities. This strong moral obligation appears to have been shaped by the observed attitude of human superiority—the belief that humans' exceptional intelligence and capability can overcome the challenge.

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<sup>72</sup> Ecological citizenship in this paper refers to the sense of the individual social responsibility toward protecting the environment in general.

Third, these studies suggest that fewer Taiwanese young adults recognize their personal responsibility in causing global climate change than the proportion that takes responsibility for attempting to resolve the problem. In other words, even though some respondents denied responsibility in causing the current situation, they were willing to take personal action to mitigate it. Moreover, most Taiwanese youth were of the mind that climate change is too overwhelming and beyond the control of a young person, but still agreed that there is something a young person can contribute to resolve the problem. It is thus interesting to find that although these young adults doubted the efficacy of a young person, they were willing to bear a degree of civic responsibility for mitigative action.

Finally, even though Taiwanese youth recognized that the industrial sector is the primary contributor to Taiwan's relatively high CO<sub>2</sub> releases, they did not allocate obligations for reducing GHG emissions solely to industry. Rather, they thought the general public should also take responsibility. This finding suggests that Taiwanese citizens do not dismiss their personal role even if Taiwan's GHG emissions are primarily generated from production-related activities.

These observations accordingly imply that Taiwanese youth not only show a strong sense of ethical obligation for protecting the environment and reducing GHG emissions, but they also recognize the social responsibility of individual citizens. It is thus particularly interesting to explore potential factors that drive this response. Based on the contextual information reviewed in Chapter 3, this paper argues that the sense of ecological citizenship is likely shaped by the influence of the contemporary environmental movement in enhancing public environmental awareness.

*The Influence of Contemporary Environmental Movement in Taiwan*

Mol (2001) argues that several drivers influence the globalization of environmental reform in Asian countries: international politics (e.g., the force of global environmental regimes, the role of international development assistance programs), international economics (e.g., the requirements demanded from global green markets), and globalization of environmentalism at a national level (e.g., strong national environmental NGOs that link to global activist networks).

Take Taiwan as an example. From an international political perspective, Taiwan is not part of the global environmental regime and does not receive international financial aid. There are not, at least on the surface, any external political forces motivating the government to address global environmental issues. Nonetheless, due to its need to participate in international affairs, Taiwan anticipates gaining some diplomatic leverage by voluntarily fulfilling its obligations as a global citizen. This is likely one of the reasons why the government has actively undertaken the process of formulating mandatory climate policies ahead of other newly industrialized and developing countries.

From the perspective of international economics, Taiwan, as a key exporting economy and a member of the World Trade Organization (WTO), will probably need to comply with potential product standards that might be established by the WTO, particular countries, or regional confederations (e.g., the European Union). While the Taiwanese government has responded to global climate change on the basis of both political and economic factors, the results of this study suggest that young adults in the country tend to endorse an ethical justification that is similar to the one endorsed by the international coalition of climate action advocates (Lin, 2008).

Lin (2008) argues that this particular discourse is endorsed by environmental activist groups in Taiwan. This observation therefore implies that the strong sense of ecological citizenship displayed by the Taiwanese youth in this study has possibly developed alongside this growing general sense of environmental awareness originating out of the contemporary environmental movement in Taiwan.

The surveys reviewed in Section 3.4 show that public environmental awareness in Taiwan has increased over the past three decades. People began to recognize their basic environmental rights to clean air and water, to prioritize environmental issues in comparison to other social problems, and to develop concern about the seriousness of the environmental impacts associated with some harmful economic activities. Even though the Taiwanese public displays inconsistent attitudes (i.e., while it tends to endorse new ideals of environmental value, it still believes in the benefits of technology and continued economic growth), a shift from a pro-development attitude to a pro-environment attitude seems to have become manifest during the period 1983-1999 (Hsiao et al., 2002).

In addition to increased environmental concern, the *2006 Environmental Protection Knowledge Survey* contained an interesting finding that is directly relevant to this emergent sense of ecological citizenship. It implied that most of the Taiwanese public was willing to lower living standards for the goal of environmental protection—a sign of willingness to compromise personal benefit and to accept individual environmental responsibility (TEPA, 2006).

The *2001 Taiwan Social Change Survey* (TSCS) further revealed that even though the majority of the Taiwanese public was reluctant to take aggressive political action (e.g., protesting in front of the factory), there was an expressed readiness to take some basic

and moderate environmentally friendly actions within the context of daily consumer and household practices (e.g., recycling and not littering) (IOSSinica, 2002). The apparent unwillingness to endorse aggressive political participation may be a result of the fact that most Taiwanese people doubt the efficacy of a citizen in influencing political decisions.

For instance, two-thirds of the Taiwanese public think that casting votes is an effective way to influence politics, but they still do not believe their opinions would be valued by government officials in the process of decision making (IOSSinica, 2009). The predisposition toward moderate behaviors (both political and personal actions) is interesting because it suggests that even though people are uncertain about the efficacy of citizenship, they would not avoid their individual environmental responsibility. In other words, they might not actively and vocally engage in activities regarding decision making, but they would still fulfill “their part” of the responsibility (e.g., recycling).

One key factor that has shaped the Taiwanese public’s mentality of individual environmental responsibility has been the rise of the contemporary environmental movement in the country. As discussed in Section 3.4, due to increased opportunities for political participation since the late 1980s, the public started to take more proactive action regarding environmental matters. While these grassroots movements were primarily initiated by local residents fighting for basic environmental rights in response to increased health threats in their communities, they primed public thinking about the importance of ensuring the quality of the environment.

Since then, numerous national environmental organizations have emerged and attracted societal attention for a broader range of environmental issues (e.g., wildlife protection, forest conservation, and water-resource preservation) and the number of

volunteers involved in environmental activities has increased as well (TEPA, 2009b). The focus of the environmental movement apparently extends beyond local demarcated issues and participation is no longer limited to residents of adversely affected communities. In other words, the issues that are now being advocated, as well as the interests that are involved, may not be directly related to the participants themselves.

Because the issue of global climate change can be related to other environmental concerns (e.g., air pollution and forest preservation), many NGOs with different interests and missions work together and develop solid alliances. This type of cooperation has been called the “packaging effect” (Buttel & Taylor, 1994). For example, the Quebec Coalition on Climate Change gathers together NGOs from the transportation, energy, resource conservation, and environmental research sectors (Perron & Vaillancourt, 1999).

This model of practice is also evident in Taiwan. Although most environmental groups in Taiwan focus on issues at a national rather than global level, they have managed to cooperate and to launch numerous campaigns aimed at increasing public understanding of global climate change. For instance, dozens of civil society groups collectively initiated several climate change-related campaigns (e.g., the “Anti-warming parade” and turn off the lights campaigns in 2007) (Lin, 2008).

Moreover, the Taiwanese government has put forth substantial effort to implement programs that encourage citizens’ actions to combat climate change in terms of energy conservation. It is of particular interest to find that these campaigns primarily focus on the responsibility of citizens (and consumers). These citizen-centered movements may also explain why Taiwanese youth display such a strong sense of ecological citizenship.

### Summarized Discussion

While Patchen (2006) argues that two key motivations for people to take action to combat climate change include utilitarian concerns (i.e., rational judgment pertaining to net benefits) and emotional concerns (i.e., fear of being threatened by climate change impacts), this case study reports on a third justification: ethical responsibility. The Taiwanese young adults that participated in these studies exhibited a strong moral rectitude that drives their willingness to take climate-protection behaviors. This dissertation research discusses the strong sense of “ecological citizenship” in Taiwan and relates this disposition to developments around the contemporary environmental movement over the past three decades (in enhancing public environmental awareness).

The finding is important because it provides a constructive source of traction for policy makers who are attempting to communicate and persuade the Taiwanese public to reduce its personal carbon footprint. Appreciation of the political and cultural context underlying the public’s attitudes, understandings, and behaviors is significant for policy makers in order to formulate acceptable actions. Global climate change may first and foremost be regarded as a scientific issue among scientists and policy makers, but it is viewed as an ethical issue by the general public. For example, one of the key messages in the film *An Inconvenient Truth* is the moral obligation to mitigate global climate change. This may be the reason why this film has successfully attracted the public’s attention around the world.

### **6.2.3 Scientists, Citizens, and Policy Making**

As discussed in Subsection 2.2.5, research on the public understanding of science has developed over the past few decades in accordance with three primary research

paradigms: *science literacy* (i.e., the level of public scientific knowledge); *public understanding of science* (i.e., the relationship between attitudes and knowledge toward science); and *science and society* (i.e., the potential social and cultural factors that may influence people's scientific understanding). Even though this case study finds that scientific knowledge is less influential than attitudes in determining individual behaviors, it merits exploring two lines of inquiry regarding research on the public understanding of science with respect to global climate change.

#### *Public Understanding of Specific Scientific Issues—Environmental Issues*

While the public in modern techno-industrial democratic society may for a variety of reasons need to have a better scientific understanding (e.g., practical functionality, democratic resilience) (Durant et al., 1989), the term “science” refers to a generalized concept that covers a wide range of scientific fields (e.g., chemistry, medical science, biology). The development of a scientifically literate citizenry is challenging because it requires a certain proportion of the population in a society (the level is uncertain) to have familiarity with a wide range of scientific subjects. Nonetheless, the public understanding of environmental issues raises several particular issues.

First, one key reason for public ignorance of science is that people tend to perceive some factual knowledge as irrelevant to their needs and interests in their daily life (Turney, 1996). For example, understanding scientific facts like the earth orbits around the sun and electrons are smaller than atoms is perhaps important for the continuity of human culture, but the lack of this knowledge does not seem to affect people's everyday life and policy decisions (for the purposes of practical functionality and democratic resilience). It is apparent that what privileged scientists assume people

need to know may not conform to what people think they need to know (and what they actually need to know).

Regardless of varying personal interests in different scientific fields, it seems inevitable that some scientific subjects are more relevant to daily life and some are more distant from it. Among the range of scientific disciplines, it can be reasonably argued that scientific knowledge of environmental issues is relatively more relevant in terms of potential health risks (e.g., various forms of environmental pollution), quality of life (e.g., recreation in national parks), and individual environmental footprints (e.g., energy consumption). Although some local environmental problems are likely only relevant to people in nearby communities, everyone is entitled to express concern about his/her own surroundings. This reasoning implies that the public should be motivated to understand environmental issues.

In addition, as discussed in Section 2.2, due to the increased scientific complexity and uncertainty of modern techno-industrial societies, problems have evolved from being conceptualized from the standpoint of the disinterested empiricist approach (the problem exists as an objective scientific phenomenon) to a multidisciplinary postempiricist approach (the problem is constructed by a variety of social interactions). This shift is particularly true for complex environmental problems. Take global climate change as an example. This dilemma is no longer recognized simply as a scientific issue. There is broad acceptance of the fact that the public needs to comprehend not only scientific aspects of the problem, but also other related aspects of it (e.g., political negotiations, economic impacts, and social inequalities).

Furthermore, the notion of socially constructing environmental problems raises an intriguing challenge for science communication. One of scientists' functions in the policy-making process is education and communication. Although they may try to provide objective scientific expertise, it is difficult to remain impartial when discussing environmental issues because most of them are not value-free. When scientists observe potential threats and issue warnings to the public, they unavoidably convey, as part of the process, their own value judgments. For example, when a trend of increasing global average temperature is observed, the public would expect scientists to directly provide insight on the implications of this observation: is it good or is it bad? As a result, scientists may pass their values to the public when communicating the science of the problem.

Finally, an interesting point of inquiry regarding the public understanding of science for environmental problems is that some policy decisions inevitably involve contradictions between technological and environmental objectives. A salient example concerns the controversy between the generation of nuclear power and the management of radioactive waste. Another centers on the debate between agricultural biotechnology and ecological ethics. On one hand, how should policy makers and scientists communicate these competing notions to the public? Do they give equal treatment to the advantages and disadvantages of both options? On the other hand, how might the public process this conflicting information? Are they making better decisions because they are well-informed or making poorer decisions because they are confused by competing information? Moreover, will there be a difference of attitudes about and understanding of competing scientific issues (they love and know one and hate and ignore the other one)?

While this case study does not address this issue, it would certainly be valuable to explore in the future.

### *Integration of Scientists and Citizens in the Policy-making Process*

The paradigm of science and society not only investigates the level of public scientific literacy and the linear relationship between attitudes about and knowledge of science, but also explores the underlying social and cultural factors that can influence the public's scientific understanding. The results of this case study reveal some valuable insights about the dynamic relationship between scientists and citizens in Taiwan.

First, Taiwanese young adults demonstrate a high level of trust in scientists. Compared with other sources (e.g., environmental activists and journalists), respondents considered scientists and related experts to be the most reliable source of information and a majority of them trusted scientists on the issue of global climate change completely or mostly. This study argues that this strong regard for scientists is possibly an outcome of the significant cultural status of Confucius in Taiwanese society. Due to his influential role, teachers, scientists, and other purveyors of expert knowledge have traditionally enjoyed high respect in Taiwan. As a result, people tend to accept the opinions of experts with few reservations. However, this sword cuts two ways and a society that venerates elitism may undermine the lay public's sense of citizenship, particularly when it comes to the expression of personal views.

Second, in the case of global climate change (or other global environmental issues), the scientific information that the public in Taiwan (or any nation) receives is usually from second-hand sources (i.e., international scientific research agencies such as IPCC). It seems inevitable that the national media would only summarize and transmit

certain key findings of scientific research. Accordingly, news articles often lack comprehensive background regarding the scientific research and the relevant institutions that carried it out. It is therefore particularly interesting to explore whether the public is capable of distinguishing scientific uncertainties and making reasoned judgments on the basis of limited information—will they posit doubts or simply accept the disseminated information?

Finally, the objective of scientist-integrated public participation practices is to reach well-informed and socially acceptable policy decisions by creating a platform where a variety of policy actors (e.g., citizens, scientists, and policy makers) can communicate and exchange opinions. The experimental exercise in this case study (i.e., IA focus groups) demonstrated a successful experience with several valuable findings. The dialogues observed during the group discussion suggest that the invited scientific experts were quite effective in enhancing participants' scientific knowledge and the respondents were able to engage in meaningful deliberation.

The participants contributed to the quality of domestic climate policies by providing several innovative ideas and feedback about compliance with certain policies. However, the key problem is how much policy makers value these lay perspectives. Do they take this input into consideration when making final decisions? Do they think these participation practices simply serve a symbolic purpose to justify democracy (an opportunity for scientists to inform people and an outlet for people to express their opinions)? The attitudes of policy makers become especially important for the democratization of Taiwan and the development of citizenship because the public has usually doubted the efficacy of citizen engagement.

#### 6.2.4 Concluding Remarks

This case study finds that Taiwanese young adults display a strong sense of ecological citizenship and that scientific knowledge is not especially influential in terms of determining individual behavioral intentions. This section discusses the social and cultural factors that underlie these two observations. First, this dissertation research argues that ecological citizenship in Taiwan is likely influenced by development of the contemporary environmental movement (in enhancing public environmental awareness).

This study finds that scientific knowledge is not a necessary prerequisite for effective policy making due to the weak correlation between scientific knowledge and behavioral intentions. Nonetheless, there are two interesting points of inquiry regarding research on the public understanding of science for environmental issues and global climate change. Environmental problems are highly relevant to people's daily life so the public should be more motivated to develop familiarity with the subject. In addition, scientists need to be cautious in communicating environmental issues to the public because these problems may involve multiple scientific disciplines and may easily involve personal value judgments.

Moreover, the participatory exercise revealed several insights regarding the dynamic relationship between scientists and citizens. The high level of trust in scientists observed in Taiwanese youth is possibly influenced by a culture of venerating elitism. With the assistance of scientific experts, the participants were capable of undertaking meaningful deliberations over the development of informed policy decisions. The key challenge is to improve the attitudes of policy makers to respect lay perspectives.

## 6.3 Conclusion

### 6.3.1 Introduction

Global climate change is a challenging problem for human society because its identification and eventual solution involves a variety of academic disciplines and societal actors. Mitigation will require not only multidisciplinary collaboration, but also collective and sustained effort on the part of all nations. While obtaining domestic support is significant for effective international cooperation, it is important to enhance current understanding of the integration of science and the public in the domestic policy-making processes for global climate change.

By employing three constituent studies (i.e., IA focus-group workshop, the pre- and post-survey, and the web-based survey), this case study investigates the human dimensions of the issue, ranging from its micro-individual aspects (i.e., exploring personal understanding of and responses to the problem) to its macro-structural aspects (i.e., examining underlying social and cultural factors in shaping the integration of science and citizens in the policy-making process).

This section reviews some important results of this case study. Subsection 6.3.2 summarizes several key findings regarding the constituent elements and the relationships pertaining to the public understanding of climate science that were observed in the empirical part of this doctoral research. Subsection 6.3.3 describes what this case study contributes with respect to several unique perspectives for further comparisons and the implications of domestic climate policies. Subsection 6.3.4 further discusses some inquiries that are of potential interest for further research. The last subsection concludes with some summarizing remarks.

### 6.3.2 Summary of Findings

Three constituent studies (i.e., the IA focus-group workshop, the pre- and post-survey, and the web-based survey) were designed in combination to achieve three objectives: 1) to examine the concerns of Taiwanese young adults about global climate change (i.e., attitudes, scientific knowledge, and behavioral intentions); 2) to investigate the interrelationships among these three elements; 3) to assess the effectiveness of the IA focus groups in enhancing individual scientific understanding and engagement in policy making. These studies generate three primary and several secondary findings that are summarized below (also see Section 5.3 for detailed results and analyses).

1. Most Taiwanese young adults display positive concerns about global climate change in terms of their tendency to endorse pro-climate protection attitudes and willingness to take pro-climate protection behaviors and to support climate policies in general. This research further suggests that these dispositions are based on a strong sense of ecological citizenship (i.e., individual social responsibility toward the environment) that is likely attributable to the contemporary environmental movement in Taiwan.
  - Most Taiwanese young adults are convinced that global climate change is real and has already become manifest and human activities are the main driving force behind this phenomenon.
  - Scientists and experts are the most reliable information source for these young adults who have a high level of trust and faith in elite forms of knowledge.
  - Most of these young adults are concerned about adverse impacts of global climate change and believe that the problem is relevant to them personally.
  - Most of these young adults agreed that there is still something a young person can contribute to resolving the problem even though they expressed doubts about the power and efficacy of a young person.
  - Most of these young adults display a pro-environmental attitude in terms of political priority and potential conflicts with economic growth, but this perception does not necessarily relate to global climate change.

- A near unanimity of Taiwanese young adults asserts that the country should begin to reduce its GHG emissions.
  - These young adults support a variety of domestic climate-mitigation policies except the nuclear energy alternative.
  - These young adults are willing to change a variety of personal behaviors to combat climate change except actions associated with green consumption.
2. The level of scientific understanding of most Taiwanese young adults with respect to global climate change is extensive in basic knowledge, but limited in specific scientific facts. This research further finds that scientific knowledge is not especially influential as a positive attitude in determining individual behavioral intentions.
- A majority of Taiwanese young adults are able to correctly identify several direct causes of global climate change. They have a better level of understanding of adverse impacts of climate change and have a poorer level of knowledge about mitigation strategies.
  - While these young adults have basic scientific knowledge of global climate change, they display a limited understanding of advanced scientifically factual knowledge, specific technologies, and specific policy information.
  - Most of these young adults have a tendency to confuse global climate change with stratospheric ozone depletion.
  - There is a positive relationship between the belief in anthropogenic climate change and the level of perceived personal relevancy.
  - There are positive relationships between attitudes (i.e., the level of concern about climate change and the level of perceived personal relevancy) and behavioral intentions (i.e., personal behaviors and policy preferences).
  - There is a positive relationship between willingness to take climate protection behaviors and the tendency to support climate policies.
  - There are statistically significant but weak relationships between the level of scientific knowledge and the level of perceived personal relevancy and behavioral intentions.
3. The experimental exercise in public participation involving the integration of scientific experts (i.e., IA focus groups) enhanced individual scientific understanding and policy making. This research suggests that this process can provide a platform

where participants can exchange opinions and share valuable lay perspectives (e.g., innovative ideas and difficulties of compliance with related policies).

- The experimental IA focus groups helped the participants to bridge to some degree the gap of scientific illiteracy of global climate change. Although participants' basic understanding of causes, impacts, and mitigation actions were not significantly changed, the level of factual scientific knowledge and the level of uncertainty did significantly improve after the IA focus groups.
- The IA focus groups also enhanced the participants' level of support for climate policies.

### **6.3.3 Contributions of this Research**

While Chapter 1 briefly highlighted the expected potential contributions of this doctoral research, the discussion here reviews the actual contributions in accordance with the results that were generated during the course of the investigation. First, this research represents completion of a successful case study on the human dimensions of global climate change in Taiwan. This is a valuable achievement in light of the fact that most extant social scientific studies on this issue have been conducted in North America and Europe. As the focus of mitigation responsibility begins to expand to developing countries (mostly located in Asia, Africa, and South America) during the post-Kyoto period, it will be important to know how people in these regions perceive the problem and evince preparedness to respond to it. Their voices deserve to be heard. This study reports on the views of Taiwanese youth and the results turn out to be quite surprising—people are reasonably concerned about climate change and are fairly willing to implement measures to address the problem.

Second, a case study of Taiwan holds value because the society has several noteworthy characteristics that make the results comparable with studies conducted in other countries that may share similar characteristics (e.g., high responsibility or high

vulnerability). Cross-country comparisons are potentially beneficial for the success of international agreements because valuable lessons can be learned and shared. For example, Taiwan may be the first newly-industrialized and developing country that attempts to implement mandatory GHG emissions regulations. While the government has initiated this effort, environmental groups have played a significant role in enhancing the public's environmental awareness and sense of individual social responsibility.

Third, this research is especially meaningful because young adults, the targeted study population, represent not only a sizable subpopulation, but also bring to bear the perspectives of a younger generation on implementing policies consistent with sustainable development. These young adults ground their sensibilities in an ethical justification. This finding is particularly interesting from the standpoint of the relationship between intergenerational justice and sustainable development.

Fourth, this research successfully executed a process of public participation whereby policy decisions were deliberated within a cost-effective framework (i.e., IA focus groups). Supplemented with the pre- and post-surveys, the IA focus groups demonstrated their effectiveness in terms of enhancing individual scientific understanding and facilitating the design of socially acceptable policies. In addition, respondents made numerous comments and provided valuable recommendations during the process of discussion. This exercise is an encouraging experience and holds potential for further implementation on a larger scale in Taiwan and elsewhere.

Finally, Taiwanese young adults appear to be motivated by a unique disposition that prompts their attitudes about pro-climate protection and behavioral intentions: ecological citizenship. While this dissertation suspects (may require further investigation)

that a culturally embedded form of Confucianism may have influenced and shaped the sense of strong individual social responsibility, it would be interesting to see whether similar sensibilities are observable in other Asian societies. Given that Taiwan shares a similar ancient culture with China, a notable contribution of this case study is that it can be regarded as an exploratory investigation for future social science research on the most populous and economically dynamic country in the world.

#### **6.3.4 Directions for Future Research**

While this case study has addressed several inquiries and made some contributions, it also triggers many ideas for future investigation. First, due to the need to maintain the feasibility of the field work, the research methods were designed to be carried out with limited human and financial resources. Not only were the IA focus groups experimental and of small scale, the quantitative survey relied on the Internet and convenience-sampling techniques. The self-selected respondents that participated in this research may represent a group of people that displays an unusually high level of environmental concern. Accordingly, future research should extend the scope of the study to a larger sample size that has been assembled on the basis of randomized selection.

Second, this case study was targeted to the perspectives of youth with respect to global climate change. The unique perspectives of young adults can (and should) in the future be compared to the viewpoints of other age cohorts and other major civil society groups. A comparative study of different age cohorts would help to shed light on possible intergenerational differences. Moreover, a research project geared toward considering different civil society groups could be useful in establishing a comprehensive understanding of different societal viewpoints.

Third, the IA focus groups in this study were designed on an experimental basis. A shortcoming was the lack of involvement of policy makers in the deliberative process. In contrast to recent civic engagement projects in Europe, the notion of public participation in Asian societies is still a relatively underdeveloped idea. Further research should be pursued to explore how institutions respond to the actors, the mechanisms, and the outcomes of public participation in the policy-making process at a macro-structure level.

Fourth, this study offered a preliminary appraisal of the influence of Confucianism on the Taiwanese people's sense of citizenship and attitudes toward scientific experts. This purported relationship opens up opportunities for research in the field of political sociology and cultural studies on the public understanding of science in Asian societies. For instance, how does the public value science and technology (a concept usually associated with modern western societies) in traditional eastern societies?

Finally, this case study demonstrates that a high level of scientific understanding of climate change is not necessarily a prerequisite for effective policy making. In other words, people do not need to know a lot to care about the future of the planet or to take actions to change course from the current trajectory. There are without question underlying social, political, and cultural factors that influence public attitudes and behaviors. Subsection 6.2.3 discusses several intriguing lines of inquiry that can be considered with respect to research on the public understanding of science (e.g., the relationship between attitudes about science in general and attitudes about science as applied to in specific issues).

### 6.3.5 Concluding Remarks

This research finds that Taiwanese young adults have a tendency to endorse attitudes and behavioral intentions that mitigate global climate change and that their level of scientific understanding of the problem is extensive in basic knowledge, but limited in specific scientific facts. In addition, attitudes (the level of concern and personal relevancy) are more significant factors than scientific knowledge in determining personal behavioral intentions and policy preferences. In other words, scientific knowledge does not appear to be a necessary prerequisite for effective policy making.

This case study of Taiwan provides several contributions that are relevant for purposes of future comparison: the views of young adults in a newly-industrialized Asian society with high responsibility for and high vulnerability to global climate change. In addition, this research marks completion of a successful exercise in public participation and in deliberating public policy decisions (i.e., IA focus groups). This case study is moreover potentially useful as an exploratory investigation for future social science research on the human dimensions of climate change in China.

Despite these valuable outcomes, this research triggers many questions for future investigation including a larger-scale national study, a comparison to other age cohorts and other major civil society groups, a contrast with public participation studies in other societal contexts, a review of public understanding of science from the standpoints of political sociology and cultural studies, and a formulation of in-depth studies on the public understanding of science and the role of scientists and citizens in the policy-making process.

## 6.4 Summary

Global climate change is a pressing and challenging issue with high scientific complexities and uncertainties. To effectively mitigate the problem (from the point of identifying the problem by assembling scientific evidence to formulating and implementing policy interventions) will require intense and protracted interdisciplinary cooperation and collective efforts from all nations. One decisive factor for the success of international regimes and cooperation is obtaining sufficient domestic support. Therefore, it is important to understand how various social, economic, and political factors affect society's support in individual countries.

Global climate change is the collective result of individual activities (though at different intensities) around the world. The problem can only be ameliorated if a significant proportion of the human population begins to act personally and politically. Individual actions are not only purely personal responses (i.e., to change lifestyle choices), but also broader political responses—being active participants in the political process (i.e., to change laws and policies). If people are part of the problem, there is little questioning that that they should be part of the solution. The foremost step is to initiate public awareness and recognition of the necessity for responsible action. Science communication and social learning will be essential parts of this process.

The public must be engaged in the policy-making process to ensure compliance with policy decisions. However, meaningful public participation in the pursuit of societal consensus over controversial decisions inevitably requires scientific experts to communicate privileged information to lay people as part of deliberative processes. This study found that scientific knowledge is not a significant determinant of personal

behavioral intentions. Accordingly, underlying factors (e.g., social, political, and cultural) and social relations (e.g., the relationship between scientists and citizens) need to be addressed regarding the level of public understanding of science.

Interestingly, while Taiwan is technically not obligated to reduce its GHG emissions, the results report with near unanimity that Taiwanese youth think that the government should begin to reduce its GHG releases. In addition, these young adults display a unique view—ecological citizenship—that contends that there is a need to assume individual social responsibility and to maintain moral obligations toward environmental protection. This case study concludes that the ethical justification is likely driving Taiwan's pro-climate protection attitudes (e.g., concerns about adverse impacts, and personal relevancy) and behavioral intentions (i.e., personal behaviors and policy preferences).

Decades after the UNFCCC and the Kyoto Protocol were negotiated, human-produced GHGs are still growing. As the Kyoto Protocol is about to expire in 2012, each nation (both industrialized and developing countries) should arguably begin to take more proactive actions to address the problem. Although Taiwan's meaningful achievement in reducing its GHG emissions needs to be monitored into the future, this case study demonstrates how an industrialized Asian society can incorporate scientists and citizens in the domestic climate policy-making process.

## APPENDIX A

### SURVEY INSTRUMENT FOR THE PRE- AND POST-SURVEY (ENGLISH)

#### Survey on Global Climate Change

##### Section I

1. Indicate your familiarity with the following terms and policies.

	Very Familiar	Mostly Familiar	Familiar	Somewhat Familiar	Not Familiar At All
Global Climate Change	<input type="checkbox"/>				
Global Warming	<input type="checkbox"/>				
Greenhouse Effect	<input type="checkbox"/>				
Kyoto Protocol	<input type="checkbox"/>				
Taiwanese Greenhouse Gas Reduction Bill (draft)	<input type="checkbox"/>				

2. When people talk about climate change, what kind of change do you think they are talking about?  
<You may select more than one option>

- Increase/decrease in air pollution
- Increase/decrease in atmospheric oxygen concentration
- Increase/decrease in precipitation (e.g., rain)
- Sea-level rise/fall
- Change in seasonal variability
- Stratospheric ozone depletion
- Rise/fall in local temperatures
- Increase/decrease in ultraviolet light intensity
- Change in daily weather
- Do not know

3. In your opinion, which of the following conditions has Taiwan experienced during the past decade?  
<You may select more than one option>

- Summer is hotter
- Summer is cooler
- Summer is longer
- Summer is shorter
- Winter is warmer
- Winter is colder
- Winter is longer
- Winter is shorter
- Droughts are longer
- Droughts are shorter
- Precipitation intensity (i.e., the volume of precipitation in a short time) is stronger
- Precipitation intensity (i.e., the volume of precipitation in a short time) is weaker
- None of the above
- Others: \_\_\_\_\_

4. Which one of the following statements comes closest to your own point of view about global climate change?

- It is real and has already started to happen.  
 It will start happening within my lifetime.  
 It will start to happen, but not until 100 years from now.  
 No, it will never happen.  
 Do not know.

5. How concerned are you about the potential for adverse effects resulting from global climate change?

Extremely High Level of Concern	Fairly High Level of Concern	Moderate Level of Concern	Fairly Low Level of Concern	Extremely Low Level of Concern	Not Concerned at All
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. Provide your assessment of the following statement: "Human activities are the main driving force behind global climate change."

Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Do Not Know
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

7. Select your top three policy priorities for government action from the following list of issues in terms of the level of urgency and importance.

- Economic growth  
 Educational opportunity  
 Energy (supply) security  
 Environmental protection  
 Gap between the rich and the poor  
 Health care  
 National security  
 Public safety  
 Social welfare  
 Unemployment  
 Others: \_\_\_\_\_

8. Select your top three priorities for government action from the following list of environmental issues in terms of the level of urgency and importance.

- Acid rain  
 Air pollution  
 Biodiversity  
 Disease and public health  
 Global climate change  
 Hazardous and radioactive waste management  
 Natural ecosystem destruction  
 Solid waste and recycling  
 Stratospheric ozone depletion  
 Water pollution  
 Others: \_\_\_\_\_

9. Provide your assessment of the following statement: “Industrialized countries (i.e., Japan, Germany, and the United States) are responsible for global climate change and they should take more responsibility to resolve the problem.”

Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Do Not Know
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10. Select from the following list the three entities that you think have primary responsibility for resolving global climate change?

- Environmental Groups  
 Every citizen  
 Industries  
 Media  
 National government  
 Scientists  
 No specific entity  
 Others: \_\_\_\_\_

11. Provide your assessment of the following statement: “My daily activities contribute to global climate change.”

Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Do Not Know
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

12. Provide your assessment of the following statement: “Global climate change may impact me personally in my lifetime.”

Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Do Not Know
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

13. Provide your assessment of the following statement: “The problem of global climate change is so overwhelming that it is really beyond the control of a young person such as me.”

Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Do Not Know
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

14. According to some experts, environmental issues involve difficult trade-offs with the economic objectives. Which one of the following statements best describes your own view?

- The highest priority should be given to protecting the environment, even if it reduces economic growth.  
 Both economic and environmental goals are important, but the environment should come first.  
 Both economic and environmental goals are important, but the economy should come first.  
 The highest priority should be given to promoting economic growth even if it causes harm to the environment.  
 Do not know.

**Section II**

1. Select from the following list the activities that contribute directly to global climate change. <You may select more than one option>

- Individual automobile and motorcycle drivers
- Industrial manufacturers emitting greenhouse gases during the production process
- Industries using electricity to manufacture products
- People using aerosol spray cans
- People using electricity in their households to operate, for example, air conditioning
- People using chemicals to deter insect pests
- Thermal power plants using fossil fuels like oil and coal to generate electricity
- Nuclear power plants
- Human destructing forests
- Human destructing the ozone layer by emitting Chlorofluorocarbons

2. Select from the following list the potential consequences that are contributing directly by global climate change. <You may select more than one option>

- Increasing average global air and ocean temperatures
- Increasing chances of skin cancer due to exposure to excessive ultraviolet light
- Increasing frequency and intensity of extreme weather
- Increasing pesticide residues in food products
- Increasing radioactive waste
- Change in precipitation volume (i.e., increasing flood and drought, water resource shortage)
- Decreasing agricultural productivity
- Decreasing biodiversity
- Decreasing vector-borne diseases
- Global average sea level rise
- Melting glaciers and ice cap in mountain and polar region

3. Select from the following list the actions that could likely moderate the effects of global climate change. <You may select more than one option>

- Industries implementing carbon capture and storage technology (i.e., storing carbon dioxide underground or in the oceans)
- Industries developing more energy-efficient products
- Government planting trees
- Government deploying large mirrors to reflect some solar energy into space
- People reducing usage of chemicals to deter insect pests
- People conserving energy/electricity
- People reducing usage of aerosol spray cans
- People using public transportation
- Power plants reducing nuclear power generation
- Power plants using renewable energy source instead of fossil fuel source

4. Yes or No Question. Please indicate whether the following statement is correct. Do not worry if you do not know the answer as this is not a test. If you do not understand the item, you may leave it blank.

	Yes	No	Do Not Know
1. The greenhouse effect is a natural phenomenon that moderates the earth's average surface temperature within a relatively comfortable range.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The greenhouse effect is due to the reabsorption of outgoing ultraviolet rays by atmospheric greenhouse gasses.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The global atmospheric concentration of carbon dioxide has increased 35% since the Industrial Revolution during the middle of the nineteenth century. The increase exceeded the range of natural variability in the earth history.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. The most important and abundant anthropogenic greenhouse gas is carbon monoxide.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The average global temperature has risen 0.76 degrees Celsius over the past 150 years.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The global average sea level rise during the twentieth century is estimated to have been 0.17 meters.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. If the global concentrations of all greenhouse gases and aerosols had been kept constant at year 2000 levels, further warming could be stopped.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. If humans continue to use fossil fuels and to emit greenhouse gasses at or above current rates, the global average temperature is projected to rise approximately 4 degrees Celsius by the end of the current century.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. If humans continue to use fossil fuels and to emit greenhouse gasses at or above current rates, the global average sea level is projected to rise 0.26-0.59 meters by the end of the current century.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. The main purpose of the Kyoto Protocol is to reduce carbon dioxide emissions in the industrialized countries by an average 5.2% below their levels in 1990.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Taiwan has ratified the Kyoto Protocol.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. The majority of Taiwan's energy supply is derived from nuclear energy.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. The major contributor of carbon dioxide emissions (including direct emission and indirect electricity consumption) in Taiwan is the industrial sector.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Since 1990 the total carbon dioxide emissions of Taiwan has stopped increasing.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Taiwan's carbon dioxide emission per capita (per person) is above the world's average.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>





	Strongly Support	Support	Neutral	Oppose	Strongly Oppose	Do Not Know
4. Use taxes and other financial incentives to encourage reductions in greenhouse gas emissions	<input type="checkbox"/>					
5. Implement a law requiring all public buildings (e.g., offices, schools) to maintain air conditioning at temperatures of 26-28 degrees Celsius during the summer	<input type="checkbox"/>					
6. Encourage the planting of trees	<input type="checkbox"/>					
7. Support the use of nuclear power as an alternative source of energy	<input type="checkbox"/>					

#### Section IV

1. Please provide the following personal information. At no time will any of this information be used to publicly identify you with a specific set of responses.

1. Age	<input type="checkbox"/> 18-19	<input type="checkbox"/> 20-21	<input type="checkbox"/> 22~23	<input type="checkbox"/> 24 or older
2. Current Educational Status	<input type="checkbox"/> Freshman	<input type="checkbox"/> Sophomore	<input type="checkbox"/> Junior	<input type="checkbox"/> Senior
	<input type="checkbox"/> Graduate School			
3. Gender	<input type="checkbox"/> Male	<input type="checkbox"/> Female		
4. Academic Major/School	<input type="checkbox"/> Physical Sciences	<input type="checkbox"/> Engineering	<input type="checkbox"/> Agriculture	<input type="checkbox"/> Law
	<input type="checkbox"/> Management	<input type="checkbox"/> Literature	<input type="checkbox"/> Social Sciences	<input type="checkbox"/> Others:___

2. From what sources do you normally obtain information on issues related to the environment? <You may select more than one option>

Internet  
 Friends  
 Magazines  
 Newspapers  
 School  
 Television  
 Others (specify): \_\_\_\_\_

3. Have you seen either of the following films?

The Day After Tomorrow      Yes     No   
 An Inconvenient Truth      Yes     No

## APPENDIX B

### SURVEY INSTRUMENT AND FREQUENCY DISTRIBUTION FOR THE WEB-BASED SURVEY (ENGLISH)

#### Survey on Global Climate Change

#### Section I

1. Which one of the following statements comes closest to your own point of view about global climate change?

- It is real and has already started to happen. (96.5%)  
 It will start happening within my lifetime. (2.5%)  
 It will start to happen, but not until 100 years from now. (0.7%)  
 No, it will never happen. (0.0%)  
 Do not know. (0.4%)

2. How concerned are you about the potential for adverse effects resulting from global climate change?

Very Concerned	Mostly Concerned	Concerned	Somewhat Concerned	Not Concerned at All	Do Not Know
<input type="checkbox"/> (23.5%)	<input type="checkbox"/> (34.0%)	<input type="checkbox"/> (34.7%)	<input type="checkbox"/> (7.0%)	<input type="checkbox"/> (0.4%)	<input type="checkbox"/> (0.4%)

3. In general, when you hear scientists talk about global climate change, how much do you trust what they are saying?

Completely	Mostly	Some	Not much	Not at All	Do Not Know
<input type="checkbox"/> (8.8%)	<input type="checkbox"/> (51.9%)	<input type="checkbox"/> (29.5%)	<input type="checkbox"/> (9.1%)	<input type="checkbox"/> (0.0%)	<input type="checkbox"/> (0.7%)

4. In general, if you have doubts about global climate change, whose opinions will you usually tend to listen to?

- Environmental activists (15.4%)  
 Friends and family (1.8%)  
 Journalists (1.8%)  
 Politicians (0.0%)  
 Scientists / Experts (77.9%)  
 I usually ignore my doubts (2.1%)  
 Other: \_\_\_\_\_ (1.1%)

5. Provide your assessment of the following statement: "Human activities are the main driving force behind global climate change."

Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Disagree	Do Not Know
<input type="checkbox"/> (46.0%)	<input type="checkbox"/> (40.7%)	<input type="checkbox"/> (10.9%)	<input type="checkbox"/> (2.5%)	<input type="checkbox"/> (0.0%)	<input type="checkbox"/> (0.0%)

6. Provide your assessment of the following statement: "Industrialized countries (i.e., Japan, Germany, and the United States) are primarily responsible for global climate change and they should exert more individual effort to address the problem than developing countries do."

Agree	Somewhat Agree	Neither Agree Nor Disagree	Somewhat Disagree	Disagree	Do Not Know
<input type="checkbox"/> (20.7%)	<input type="checkbox"/> (43.2%)	<input type="checkbox"/> (20.4%)	<input type="checkbox"/> (13.3%)	<input type="checkbox"/> (2.5%)	<input type="checkbox"/> (0.0%)

7. Provide your assessment of the following statements:

	A	SA	NAND	SDA	DA	DK
a. My daily activities contribute to global climate change	<input type="checkbox"/> (9.5%)	<input type="checkbox"/> (62.1%)	<input type="checkbox"/> (20.4%)	<input type="checkbox"/> (7.0%)	<input type="checkbox"/> (0.4%)	<input type="checkbox"/> (0.7%)
b. Global climate change may impact me personally in my lifetime	<input type="checkbox"/> (34.7%)	<input type="checkbox"/> (58.6%)	<input type="checkbox"/> (6.0%)	<input type="checkbox"/> (0.7%)	<input type="checkbox"/> (0.0%)	<input type="checkbox"/> (0.0%)
c. There is still something a young person such as me can do to contribute to resolve the problem of global climate change.	<input type="checkbox"/> (43.2%)	<input type="checkbox"/> (49.8%)	<input type="checkbox"/> (6.3%)	<input type="checkbox"/> (0.0%)	<input type="checkbox"/> (0.0%)	<input type="checkbox"/> (0.7%)

8. According to some experts, environmental issues involve difficult trade-offs with economic objectives. Which one of the following statements best describes your own view?

- The highest priority should be given to protecting the environment, even if it reduces economic growth. (14.7%)
- Both economic and environmental goals are important, but the environment should come first. (78.6%)
- Both economic and environmental goals are important, but the economy should come first. (4.6%)
- The highest priority should be given to promoting economic growth even if it causes harm to the environment. (0.7%)
- Do not know. (1.4%)

9. Select your top three policy priorities for Taiwanese government action from the following list of issues in terms of the level of urgency and importance.

- Economic growth (50.9%)
- Educational opportunity (29.5%)
- Energy (supply) security (18.6%)
- Environmental protection (74.0%)
- Gap between the rich and the poor (38.6%)
- Health care (11.2%)
- National security (13.7%)
- Public safety (9.5%)
- Social welfare (17.5%)
- Unemployment (31.2%)
- Other: \_\_\_\_\_ (5.3%)

10. Select your top three priorities for Taiwanese government action from the following list of environmental issues in terms of the level of urgency and importance.

- Acid rain (6.3%)  
 Air pollution (54.4%)  
 Biodiversity (30.9%)  
 Disease and public health (20.7%)  
 Global climate change (38.6%)  
 Hazardous and radioactive waste management (16.1%)  
 Natural ecosystem destruction (54.0%)  
 Solid waste and recycling (30.9%)  
 Stratospheric ozone depletion (9.1%)  
 Water pollution (37.2%)  
 Other: \_\_\_\_\_ (1.8%)

## Section II

1. Yes or No Question. Please indicate whether each of the following statements is correct. Do not worry if you do not know the answer as this is not a test. If you do not understand the item, you may leave it blank.

Scientific Statement	Correct	Incorrect	DK
1. The greenhouse effect is due to the reabsorption of outgoing infrared radiation by atmospheric greenhouse gasses, such as carbon dioxide.	<input type="checkbox"/> (78.9%)	<input type="checkbox"/> (17.2%)	<input type="checkbox"/> (3.9%)
2. Industrial manufacturers emitting greenhouse gases during the production process contributes to global climate change.	<input type="checkbox"/> (87.7%)	<input type="checkbox"/> (10.2%)	<input type="checkbox"/> (2.1%)
3. Ozone layer depletion contributes to global climate change.	<input type="checkbox"/> (59.3%)	<input type="checkbox"/> (35.1%)	<input type="checkbox"/> (5.6%)
4. Deforestation contributes to global climate change.	<input type="checkbox"/> (90.9%)	<input type="checkbox"/> (8.1%)	<input type="checkbox"/> (1.1%)
5. Increasing average global air and ocean temperatures are a potential consequence of global climate change.	<input type="checkbox"/> (95.1%)	<input type="checkbox"/> (1.4%)	<input type="checkbox"/> (3.5%)
6. Global climate change has no effect on the change in precipitation volume (i.e., increasing flood and drought, water resource shortage).	<input type="checkbox"/> (11.9%)	<input type="checkbox"/> (86.0%)	<input type="checkbox"/> (2.1%)
7. Global average sea-level rise due to the melting glaciers and ice cap in mountain and polar region is a potential consequence of global climate change.	<input type="checkbox"/> (96.1%)	<input type="checkbox"/> (2.8%)	<input type="checkbox"/> (1.1%)
8. People using public transportation could likely moderate the effects of global climate change.	<input type="checkbox"/> (92.3%)	<input type="checkbox"/> (4.6%)	<input type="checkbox"/> (3.2%)
9. Industries implementing carbon capture and storage technology (i.e., storing carbon dioxide underground or in the oceans) could likely moderate the effects of global climate change.	<input type="checkbox"/> (64.6%)	<input type="checkbox"/> (13.3%)	<input type="checkbox"/> (22.1%)
10. Power plants using sources of renewable energy instead of fossil fuels like oil and coal to generate electricity could likely intensify the effects of global climate change.	<input type="checkbox"/> (33.0%)	<input type="checkbox"/> (52.6%)	<input type="checkbox"/> (14.4%)
11. The main purpose of the Kyoto Protocol is to reduce carbon dioxide emissions in the industrialized countries.	<input type="checkbox"/> (90.2%)	<input type="checkbox"/> (4.6%)	<input type="checkbox"/> (5.3%)
12. Taiwan's carbon dioxide emission per capita (per person) is above the world's average.	<input type="checkbox"/> (66.3%)	<input type="checkbox"/> (11.6%)	<input type="checkbox"/> (22.1%)

### Section III

1. Do you think that Taiwan should begin to reduce its greenhouse gas emissions?
  - Yes (Proceed to Question 2 in this section and skip Question 3) (98.9%)
  - No (Proceed to Question 3 in this section) (1.1%)
  
2. Taiwan should reduce its greenhouse gas emissions because the country \_\_\_\_\_ <You may select more than one option>
  - May face trade sanctions from the rest of the world. (20.6%)
  - Has relatively high greenhouse gas emissions per capita (per person). (53.5%)
  - Will be affected by the adverse impacts resulting from global climate change. (72.3%)
  - Will benefit economically from action to reduce its emissions in the long term. (36.5%)
  - Is a member of the global community and the country does not have the right to destroy the environment. (83.0%)
  - Other: \_\_\_\_\_ (2.1%)
  
3. Taiwan does not need to reduce its greenhouse gas emissions because the country \_\_\_\_\_ <You may select more than one option>
  - Has not signed the Kyoto Protocol. (0.0%)
  - Does not have very high overall emissions in comparison with other countries like the United States and China. (33.3%)
  - Will not be affected by the adverse impacts resulting from global climate change. (33.3%)
  - Will not benefit economically from action to reduce its emissions in the long term. (66.7%)
  - Will have future generations to devise a solution. (0.0%)
  - Other: \_\_\_\_\_ (0.0%)
  
4. Which of the following groups in Taiwan bear primary responsibility for reducing their greenhouse gas emissions?
  - Industrial sector (14.7%)
  - Household/consumer sector (1.8%)
  - Both are equally responsible (83.2%)
  - Do not know (0.4%)
  
5. Below are several statements about possible personal behavioral changes that some experts suggest could help to reduce emissions of carbon dioxide into the atmosphere. Fill in the response that most closely reflects your views in terms of willingness to take each action.

	W	SW	N	SUW	UW	DK
1. Conserve energy by reducing my use of electricity	<input type="checkbox"/> (34.0%)	<input type="checkbox"/> (48.1%)	<input type="checkbox"/> (17.2%)	<input type="checkbox"/> (0.7%)	<input type="checkbox"/> (0.0%)	<input type="checkbox"/> (0.0%)
2. Drive my car/motorcycle less and use public transportation (e.g., trains and buses) instead	<input type="checkbox"/> (41.1%)	<input type="checkbox"/> (41.8%)	<input type="checkbox"/> (14.7%)	<input type="checkbox"/> (1.8%)	<input type="checkbox"/> (0.7%)	<input type="checkbox"/> (0.0%)
3. Replace my older appliances with more energy efficient new models	<input type="checkbox"/> (32.3%)	<input type="checkbox"/> (42.1%)	<input type="checkbox"/> (23.5%)	<input type="checkbox"/> (1.8%)	<input type="checkbox"/> (0.4%)	<input type="checkbox"/> (0.0%)

6. Below is a list of several possible initiatives that could help to reduce emissions of carbon dioxide into the atmosphere. Please fill in the response that most closely reflects your views in terms of your support for each activity.

	S	SS	N	SO	O	DK
1. Encourage the development of less pollution and energy intensive industries and discourage the development of high pollution and energy intensive industries by shifting government subsidy programs	<input type="checkbox"/> (40.4%)	<input type="checkbox"/> (48.1%)	<input type="checkbox"/> (10.2%)	<input type="checkbox"/> (0.7%)	<input type="checkbox"/> (0.7%)	<input type="checkbox"/> (0.0%)
2. Implement a law regulating greenhouse gasses as air pollutants and requiring industries to reduce their emissions in accordance with legally mandated targets and timelines	<input type="checkbox"/> (39.3%)	<input type="checkbox"/> (48.4%)	<input type="checkbox"/> (10.9%)	<input type="checkbox"/> (0.7%)	<input type="checkbox"/> (0.0%)	<input type="checkbox"/> (0.7%)
3. Use taxes and other financial incentives to encourage reductions in greenhouse gas emissions	<input type="checkbox"/> (36.8%)	<input type="checkbox"/> (38.6%)	<input type="checkbox"/> (20.7%)	<input type="checkbox"/> (3.2%)	<input type="checkbox"/> (0.4%)	<input type="checkbox"/> (0.4%)
4. Encourage the planting of trees	<input type="checkbox"/> (64.9%)	<input type="checkbox"/> (28.8%)	<input type="checkbox"/> (4.6%)	<input type="checkbox"/> (1.8%)	<input type="checkbox"/> (0.0%)	<input type="checkbox"/> (0.0%)
5. Support the use of nuclear power as an alternative source of energy	<input type="checkbox"/> (13.7%)	<input type="checkbox"/> (23.5%)	<input type="checkbox"/> (43.5%)	<input type="checkbox"/> (12.3%)	<input type="checkbox"/> (6.0%)	<input type="checkbox"/> (1.1%)

#### Section IV

1. Please provide the following personal information. At no time will any of this information be used to publicly identify you with a specific set of responses.

Age	18
Gender	<input type="checkbox"/> Male (39.6%) <input type="checkbox"/> Female (60.4%)
Current Educational Status	<input type="checkbox"/> Freshman (25.6%) <input type="checkbox"/> Sophomore (13.0%) <input type="checkbox"/> Junior (27.4%) <input type="checkbox"/> Senior (13.3%) <input type="checkbox"/> Above Senior (2.5%) <input type="checkbox"/> Graduate School (Master) (15.1%) <input type="checkbox"/> Graduate School (PhD) (3.2%)
Hometown	<input type="checkbox"/>
Academic Major/School	<input type="checkbox"/> Physical Sciences (16.5%) <input type="checkbox"/> Engineering (11.9%) <input type="checkbox"/> Agriculture (3.5%) <input type="checkbox"/> Medical Science (2.8%) <input type="checkbox"/> Literature (10.5%) <input type="checkbox"/> Business (15.8%) <input type="checkbox"/> Management (14.7%) <input type="checkbox"/> Law (0.7%) <input type="checkbox"/> Social Sciences (9.5%) <input type="checkbox"/> Others: _____ (14.0%)

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