Climate Change and Global Sustainability: A Holistic Approach

Edited by
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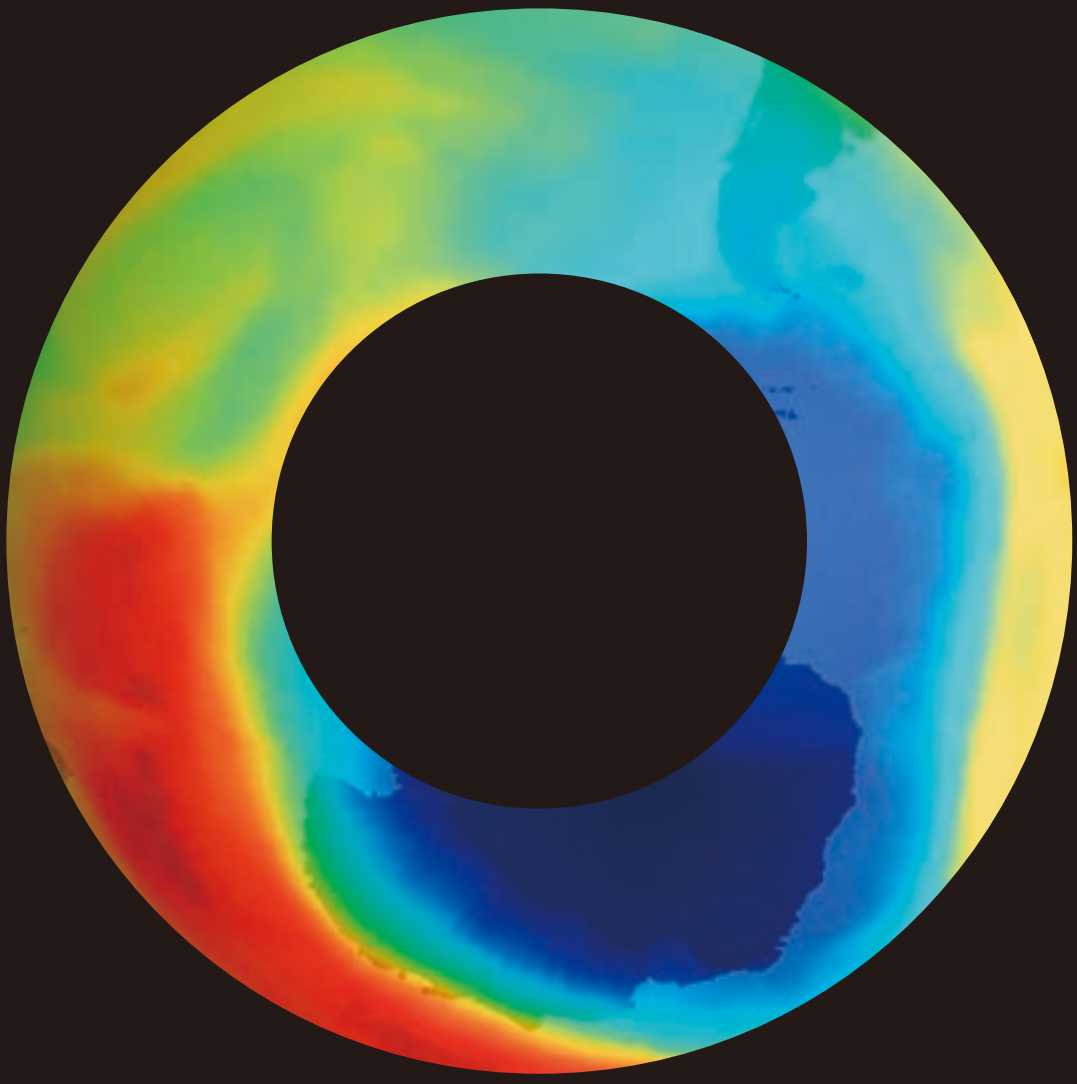

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Introduction: From climate change to global sustainability

Akimasa Sumi and Nobuo Mimura

1-1 Global warming: What kind of problem is it?

In 2007 the Intergovernmental Panel on Climate Change (IPCC) Working Group I AR4 (Fourth Assessment Report) clearly declared that the contribution of human activities to recent global warming is certainly more than 90 per cent (IPCC, 2007). This view is widely accepted by global scientific and political communities, which means that we have entered into an important stage of the global warming issue: the age of action. However, various questions will arise on entering this decision-making stage, and there may be increased levels of scepticism. It is therefore necessary to reconsider what the global warming issue means for our future and evaluate the available courses of action.

1-1-1 Perturbation to the radiative energy balance

The Earth's climate system is determined by radiative energy and material balances. With regard to energy, Earth's climate can be considered an open system; however, it is a closed system as far as most materials are concerned. Energy is measured by temperature, while a typical example of material is water (precipitation), which is a reason why traditional climate classification is based on temperature and precipitation. Temperature in the Earth's climate system is determined by the budget between incoming and outgoing energy. If the former is larger, the temperature will increase, although its distribution in the system is determined by

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processes within the system. In reality, the Earth's climate consists of many interacting subsystems that influence the distribution of energy. Precipitation also results from interactions between many processes in the climate system. At the same time, it should be noted that the Earth's climate is dynamic rather than static. The Earth has experienced many dramatic climate changes, including several ice ages.

Following the Industrial Revolution, human beings have become a component in the Earth's climate system. Through modification of the environment, we possess the power to reduce environmental constraints around us. By changing land cover and land use, we have increased our food supply. Furthermore, car use has amplified our ability to move. Emission of global warming gases associated with these human activities has resulted in changes in the minor constituent concentration in the atmosphere. This disturbs the Earth's radiative energy balance, resulting in a warmer climate.

However, perturbation induced by humankind does not only affect the radiational energy balance, but happens in many other fields as well. Thus it is concluded that the environment around us consists of interaction between various subsystems. To summarize these interactions, Komiyama and Takeuchi (2006) introduce three subsystems – the global (natural), social and human – and the various problems around us (the Earth's environmental issues) that result from the imbalance between these subsystems (see Figure 1.1). Of course it is true that there are many other

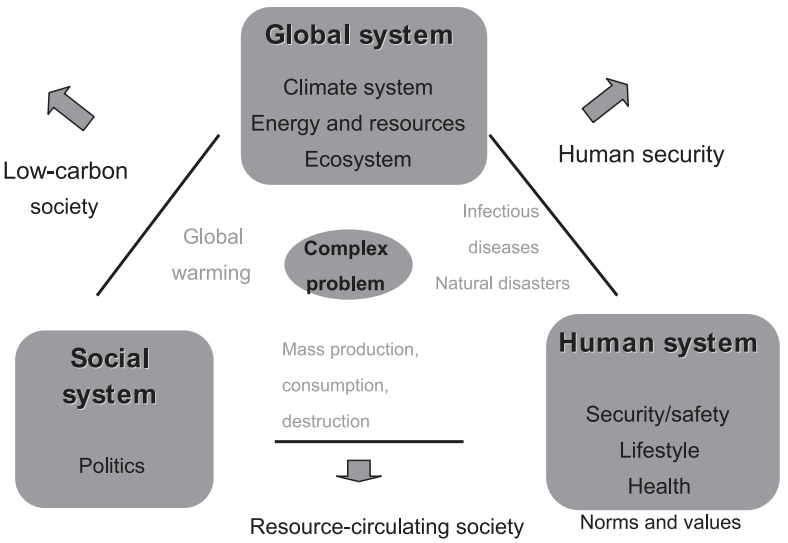

Figure 1.1 Relationship between three systems

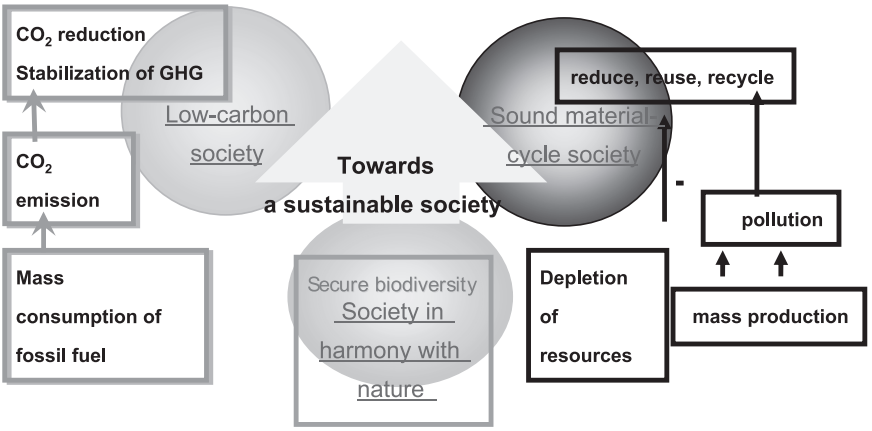

Figure 1.2 Integration of three societies

subsystems, but these three represent the three dimensions in a frame of thinking towards a sustainable society when each issue is considered.

The three societies, i.e. the low-carbon society, the resource-circulating society and the nature-friendly society, should be realized simultaneously, and an integration of each is proposed by Masui in Chapter 7. But even when action is taken to attain a low-carbon society, attention must be paid to these three interactions (Figure 1.2).

For example, the global warming issue is caused by the imbalance between the global (natural) and social systems. Greenhouse gases emitted by human activity have changed the concentration of the atmosphere, which perturbs the radiation balance in the Earth's climate system. Here it should be noted that the present climate is not the most ideal climate. The environment has evolved by adapting to climatic conditions. In other words, our society, natural resources and ecosystem services are under these climatic conditions – thus it is easy to understand that changes in the present climatic conditions will impact on our society. One result of the imbalance between the social and human systems is material circulation. Through production and consumption, we have produced many artefacts that have changed natural resources into waste. This waste production cannot continue indefinitely without consequences, and therefore a circulation of materials (recycling) is necessary.

Examples of the imbalance between the global (natural) and human systems are natural hazards such as earthquakes, tsunamis, typhoons and hurricanes. In addition to these hazards, we have to pay attention to issues in social and human systems, such as loneliness and the pursuit of a life worth living. Traditionally, issues relating to the human heart have been discussed separately from energy and material issues. However,

when we introduce mitigation and adaptation measures into a society, we have to make a value judgement about the people. In other words, if it is acceptable to make many people unhappy, we can easily reduce energy consumption. It is certain that shrinking of an economy contributes to the reduction of energy consumption; but it produces many drawbacks in the society, such as increased numbers of poor people. Therefore we have to pay attention to the well-being of individuals when we take an action.

We thus propose a low-carbon society to recover the balance between the global (natural) and social systems. Similarly, a material-circulating society is proposed to recover the imbalance between the social and human systems. Finally, creation of a society in harmony with nature is proposed to recover the balance between the global (natural) and human systems.

1-1-2 Equity between generations

Besides the natural phenomena outlined above, global warming exerts a strong influence on society, with one important issue being the resulting inequity between generations. The problems brought about by global warming are not currently urgent but will emerge in the future, suggesting that forecasting and backcasting are critical. Climate change is evaluated through climate model simulations. It should be noted that climate models depend on the scientific knowledge of the time, but uncertainties in future climate predictions are inevitable. Our climate system has a chaotic nature, and deterministic prediction for the future is, in principle, impossible. There are also interactions between human activities and the natural system which are difficult to quantify. For example, future energy use is strongly dependent on future socio-economic situations and technology development, which to some extent depend on taste and preference; people do not always base their decisions on economic factors. Human behaviour and social development involve many unpredictable aspects. However, we should not be caught in a trap of pessimism. The future is unpredictable, but there are areas in which consequences can be calculated. For example, it is certain that increased levels of carbon dioxide (CO_2) result in a warmer climate. Therefore, we have to take action based on reliable predictions and impact assessments.

1-1-3 Science and politics

It is often said that global warming is the first problem where science and policy sit at the same table. This does not mean that science has been out of politics; rather, in the past politics was the master and science the follower. This is best illustrated by the Manhattan Project in which the

world's first atomic bomb was developed during the Second World War. All scientific knowledge was mobilized to achieve a political goal. At present it is vital for politics to listen to the voice of science, but there remains a significant gap between the two fields. Politicians need all necessary knowledge, but policy usually requests more than science can provide. This provokes questions about the suitability of science for political decision-making, but it is clear that science is crucial. The present issues could not be addressed without scientific and technological knowledge. However, convincing politicians of scientific suggestions remains difficult because science relates the conclusions that follow logically from data and established theories. In contrast, politics has to pay attention to different aspects of human beings, such as desire, lust and economic values. The value system and mental situation of each individual must also be considered.

1-1-4 Understanding is critical, but action is also necessary

When issues emerge, scientists believe that we should attempt to gain a full understanding of each aspect and how it might interact with what is already known. While this is true, there are many problems that require action before complete understanding can be gained. Global warming is just such a problem.

When we take action before complete understanding, analysis of the criteria for action should be undertaken. It is easy to say that the present generation should take action on behalf of future generations, but full consideration of why and how we should act is imperative.

1-1-5 Freedom versus limitation

"Freedom, equality and fraternity" is a slogan from the French Revolution. However, these values cannot always be completely achieved simultaneously. Mankind is surrounded by many difficulties, and the conquest of nature has always been considered a victory. We now realize that human activity exerts a strong influence over our environment. Therefore, to adapt to the problems caused by global warming, we will have to introduce limits to our freedom. An example of this can be seen in the arms-reduction negotiations. To limit nuclear weapons, each country has to limit its freedom to increase its military power. To combat the problems caused by global warming, each society has to limit the freedom of maximizing its own economic interest.

People may insist upon their rights to pursue their own interests, but in some cases these may have to be forfeited. In brief, global warming creates a constraint to global politics and economics. The actions induced by

these issues need international diplomacy. The Nuclear Non-Proliferation Treaty has been created for reduction of nuclear weapons. For global warming, long-lasting international diplomacy is being procured through the activities of the UNFCCC Conference of Parties (COP)/Meeting of Parties (MOP), which has resulted in negotiation about future action following the Kyoto Protocol.

1-2 Now is the time for action

Social concern about global warming has now shifted from the scientific question of whether or not human activity contributes to climate change to real action such as adaptation and mitigation. However, on entering the stage of concrete action, we have to consider various aspects of society. In particular, there are distinct differences in position between developed and developing countries. We have to admit that developing countries have a right to develop, and the concept of "co-benefit" must be presented so that policies will be acceptable to nations at different levels of development. In the case of Japan, it is needless to say that the society is confronted with many issues, including resource scarcity, an aged society, poverty, public health and so on. It should be noted that all these issues require a solution. Each stakeholder has its own value criteria, and all are eager to have resources allocated to their own topic. Concrete action entails allocation of financial and human resources and numerous other assets, suggesting that time-consuming processes are required to reach a consensus on resource allocation among stakeholders. To reach this consensus, it is necessary for us to build a framework to tackle these problems.

1-3 Reliable tools are necessary for agreement

All action taken should be based on reliable estimates of future impacts and the probable effectiveness of any action. A reliable tool is needed for this purpose, because stakeholders naturally prioritize their own interests and profits. An objective framework is therefore necessary before a consensus can be reached, and one candidate for this is a reliable climate model combined with an integrated assessment model, as discussed by Sumi (2007). For example, recent advances in the technology of high-end super-computers are remarkable, and it is rumoured that the Exa (10^{13}) FLOPS super-computer will be available in the mid-2010s. This high-end computer will open a new era for climate modelling and increase the reliability of integrated assessment models. Many processes that are now

treated in a parameterization scheme in modelling will be given more advanced treatments. For example, clouds will be treated explicitly, which will reduce the uncertainty of climate sensitivity. Horizontal resolution will be increased, and there will be impacts at the local scale. In impact assessment modelling, various new factors including human behaviour and economics based on the tastes and actions of individual people will be added to the existing model. More reliable assessment may be possible.

Besides the advances in super-computing capability, significant advances in information network technology are expected. The success of the internet has increased the ease with which knowledge is accessed, which means that people all over the world can now easily access data describing the present status of our climate and environment. These IT contributions shape public opinion about the environment. Here, the role of the view from space via satellite remote sensing is particularly emphasized because this provides mankind with a platform to view the Earth from outside. It is also important that this view is transported to the public through the media. For example, deforestation in the Amazon, the hole in the ozone layer and the recent decrease of sea ice in the Arctic Ocean are all clearly demonstrated by satellite pictures and have thus become well known.

1-4 Structuring of knowledge

There are numerous issues resulting from global warming, and a huge volume of knowledge is produced every day. This knowledge must be structured properly to make maximum use of it. In the IPCC process, policy-relevant, rather than policy perspective, results are pursued, which is one example of an effort to structure knowledge. In this process, available peer-reviewed papers are collected and arranged by selected lead authors. Through the production process, manuscripts are reviewed by peers and governments. Finally, a summary for policy-makers is made line by line by government officials.

Another method of structuring knowledge is mapping the issues. For example, Hiramatsu, Mimura and Sumi (2008) have proposed a type of global warming mapping that provides a framework to arrange the existing knowledge.

These topics will be described in the following chapters.

1-5 Structure of this book

In this Introduction it is emphasized that global warming is a complicated issue where many factors interact with each other. In order to understand

the totality of the issue and find the weak points in our knowledge to overcome the issue, the structuring of knowledge is stressed. Our efforts to structure the knowledge of the global warming issue are described in Chapter 2, where a mapping of the global warming issue is proposed. It has a cycle with seven phases.

- Greenhouse gases are emitted due to anthropogenic socio-economic activities.
- Greenhouse gas concentration is determined through the natural carbon cycle.
- Climate change due to the change of the greenhouse gas concentration is estimated.
- Impacts due to climate change are estimated.
- Adaptation should be considered for the impacts.
- Mitigation should be considered for the impacts.
- These adaptation and mitigation options contribute to establishment of a new social structure.

This map describes a dynamic where the present structure of our society will be changed to a new structure of future society through mitigation and adaptation options relating to the global warming issue. Through this study, it is pointed out that research on adaptation and restructuring of society is weak and there are few definite images of the future society.

When we discuss the future, it should be given a time-horizon. Usually, this issue is handled in future simulation in models. There are many different types of models, from simple to complex, and it is very important to consider whether the model deserves future simulation. Regardless of the kind of model used, a degree of uncertainty is inevitable. When we consider an action for the future, we have to make a decision on criteria. Cost-benefit analysis is often used as a criterion. Then we have to estimate costs due to climate change resulting from global warming, where there are two different processes: estimate of the climate change and estimate of cost of impacts due to the climate change. Usually, climate change is estimated using a numerical simulation in a climate model. Here, accuracy of the estimate of climate change becomes important. As a final decision is made by society, it is very important to know the reliability of the estimate of climate change due to global warming. In other words, one must let society know the risk of global warming. With incomplete or imperfect information, exactly how to communicate this is very important. This aspect is discussed in Chapter 3.

As is described before, impacts of climate change due to global warming are a very difficult research theme, because there are many different topics and stakeholders. It often happens that a certain impact which is negative to one stakeholder is positive to another stakeholder. Then there is the question of the practical way to present estimates of impacts

to society. Various kind of impacts are discussed in different horizontal scales – Japanese, regional and global – in Chapter 4. Finally, optimization of adaptation and mitigation strategy is discussed.

In Chapter 5 we discuss several policy-related issues. When we take action, policy issues are inevitable. Various policy options within domestic legislation and an international framework are necessary. However, policy options alone are not sufficient. We need collaborations of many stakeholders, and among these the behaviour of private companies is important. As an example, the Shell energy scenario is presented to show how this private company is thinking about the future. Finally, the relationship between developed and developing countries becomes important. In other words, international development aid policy should be consistent with the climate change adaptation/mitigation policy.

Following policy options, we should take concrete action to transform our society. This issue is discussed in Chapter 6. It covers diverse topics, from the social system and life cycle to the role of journalism and ecophilosophy. This is inevitable when we think about reorganizing our society, because society consists of many levels with different characterizations.

Our future vision is presented in Chapter 7. It is often said that a low-carbon society should be established to overcome the global warming issue. However, we think this is not enough. As there are so many issues around us, it is not enough to pay attention to just one aspect. Given that the present situation resulted from an imbalance between the three societies – the global (natural), social and human systems – in order to realize a sustainable society we have to restore balances between these societies. You may ask why? One tentative approach is presented in Chapter 7, as the first step in this issue. This can be considered to be one of our conclusions regarding the future society, although its formulation is simple and more work will be necessary. In Chapter 8, a summary is given.

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Sustainability Science

Climate change owing to global warming is a paramount concern for society in the twenty-first century, and it is not an issue that can be solved by individual academic or scientific disciplines working in isolation. Because climate change involves a wide range of interlinked problems, solutions must be pursued in an interdisciplinary manner. This book adopts just such a holistic approach in examining various aspects of global warming, and offers readers a comprehensive overview.

First, the mapping of knowledge about global warming is presented as a framework for addressing the issue. This is followed by a discussion of risk in relation to global warming and of the communication of risk between academia and society. Impacts, adaptation strategies, the institution of a low-carbon society and a number of other policy concerns associated with climate change are then reviewed. Because human behaviour is a critical factor in the move towards a low-carbon society, issues involving quality of life are also presented, with an emphasis on philosophy. Finally, the book considers the integration of three scenarios for society – a low-carbon society, a resource-circulating society, and a society in harmony with nature – and presents a comprehensive vision of the future.

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