Special Round Table Conference on Global Environment Problems

Conditions for Survival

Toward a "Solar Energy-Based Society" Full of Vibrant Life

THE ASAHI GLASS FOUNDATION

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Introduction

The global environment today is facing an array of problems ranging from global warming, weather anomalies, increased population, food and water resource shortages, and loss of biodiversity, to regional conflicts and poverty problems.

In 1972, the Club of Rome warned in its book *The Limits to Growth* that if the population of the world continued to increase and if resources continued to be consumed with ever greater emissions of pollutants, there would be a serious impact on world development. In response, in the 1980s, the idea of "sustainable development" became widely accepted. Subsequently, at the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, the international community signed up to the Rio Declaration on Environment and Development and agreed to implement an action plan, named the "Agenda 21." This seemed to mark the beginning of human efforts to solve environmental problems. In reality, however, we entered the 21st century without seeing significant actions taken to mitigate these problems.

Even now, the majority of people seem disinclined to face this reality and imagine that someone will solve the problems for them or else they think vaguely that the problem will somehow solve itself.

Nonetheless, no one can now afford to merely sit on the sidelines in the fight against global warming and other environmental problems. Unless each and every member of the international community becomes fully aware of the seriousness of the problems and takes action, a solution will never be found.

In light of this, the Asahi Glass Foundation in the sincere hope of encouraging all people to think and act to protect the Earth by clarifying the issue and proposing solutions, asked its trustees and councilors, who have a great deal of knowledge and expertise on social and environmental problems, to take time to discuss the matter. Those discussions resulted in the publication of this book, which we feel will be a catalyst in reaching an eventual solution.

We sincerely hope that each and every one of you will read this report, think about what you can do, and actually take a step forward. We believe that this is the only way we can save the Earth from its present crisis.

In conclusion, I would like to wish you all the best of health.

April 2010

Hiromichi Seya
Chairman of the Asahi Glass Foundation

Conditions for Survival

Toward a “Solar Energy-Based Society”
Full of Vibrant Life

Contents

Publication of This Report: How This Report Came Out

Akio Morishima
Chairman of the Round Table Conference,
Trustee of the Asahi Glass Foundation

Since 1992, the Asahi Glass Foundation has awarded the Blue Planet Prize to those researchers and activists who have made significant achievements from a global perspective in their research on global environmental problems and in activities that raised awareness of global environmental problems. In 2007, to celebrate the 15th anniversary of the Blue Planet Prize, the Foundation decided on a plan to revisit what the Club of Rome did in 1972 when it published its book *The Limits to Growth*. The plan was to have a Special Round Table Conference of the trustees and councilors of the Foundation to discuss the issue of how the current generation can tackle the global environmental problems and raise awareness of these problems in civil society by also providing information on the current situation. As shown in the attached table, members of the Conference include scholars, researchers, former government officials, and businesspersons, who are all leaders in their respective fields. Although not all of them are experts on the environment, they have all acquired a deep knowledge of environmental problems through leading-edge activities in their respective fields.

The Asahi Glass Foundation appointed me as chairman of the Conference based on my association with the Foundation and my career background. I am one of the trustees of the Foundation and have long been engaged in research on environmental laws and in policy making. As chairman, I participated in the basic selection process for the basic themes to be discussed by members of the Conference and the reference materials that needed to be collected. In the creation of this report and in all other details, however, Mr. Keiichi Uchida, who was the senior executive director of the Foundation, took overall responsibility as representative of the Secretariat of the Foundation. We commissioned the work of collecting and analyzing the reference materials to the Mitsubishi Research Institute (team leader: Senior Researcher Toru Hashi).

Prior to each meeting of the Conference, the data and reference materials necessary to discuss the theme selected by the Secretariat for the meeting were distributed to each of the members. Members discussed the theme for a total of four hours per meeting: two hours in the morning and again in the afternoon. At the beginning of the meeting, the staff of the Secretariat gave a brief explanation of the reference materials and I explained the key points in the theme under discussion. However, most of the time was spent among the members freely discussing the theme.

Conference members had their first meeting in December 2006 and have met eight times in total, with the last meeting held in November 2009. In March 2009, the Conference published its interim report under the same title as this report (Conditions for Survival). Just like the interim report, the final report of the Conference was aimed to be both excellent in content and readable by a wide range of the public.

Part 1 of this final report outlines current global environmental problems and serves as an introduction to the entire report. Part 2 gives the results of the Conference discussions. Chapter 1 summarizes the data and reference materials that were submitted to the Conference, and demonstrates how serious

current environmental problems are by giving actual data on global warming, loss of biodiversity and others. Chapters 2 and 3 summarize the results of the discussions. Here the Conference proposes the concept of a "solar energy-based society" as a new societal vision (image) for the 21st century together with the measures to be implemented to achieve that vision. In fact, the heated discussions that took place at the Conference covered so diverse dimensions that it was not feasible to incorporate in the report all the opinions given by the members all of whom provided expert knowledge from various perspectives. Thus, the report presents the highest common factors in my judgment that all members agreed with, including the concept of a "solar energy-based society."

This report is based on the following fundamental ideas: (1) the human race, as a living being, bases its existence on nature; (2) therefore, if human society damages nature, the human race cannot survive as a living being; (3) it is therefore necessary for the human race to aim at creating a society that will not damage nature in the 21st century, and in this report we call such a vibrant society a "solar energy-based society." And (4) in creating a "solar energy-based society", human activities must be within the limits of and not countering the natural rule, and to these ends, in their relations among themselves and with society, it is important for people to have respect for others and for nature and to live in harmony, instead of confronting and competing with each other. In the final chapter of Part 2, this concept is outlined and summarized in some detail.

In Part 3, eight Blue Planet Prize laureates contributed messages, expressing their opinions on global environmental problems.

In preparing this report, I would like to thank the members of the Conference for providing their expert knowledge and a range of new and innovative ideas. I also would like to express my heartfelt gratitude to former Senior Executive Director Mr. Keiichi Uchida, who coordinated the diverse discussions at the Conference over the last three years, culminating in the creation of a vision for a new "solar energy-based society."

Although I was responsible to Chairman Seya and the trustees and councilors of the Foundation for the final form of the report, it would never have been completed without the committed involvement of Mr. Uchida and other members of the Secretariat. I also would like to take this opportunity to thank Chairman Seya for allowing me to postpone publication of the report several times in our efforts to ensure that it would be the best we were capable of producing.

We welcome your opinions and criticisms on our concepts of a "solar energy-based society" and "consideration for others" (including nature and other living beings) proposed in this report. Please send them to the Asahi Glass Foundation. With the publication of this report, the Conference has completed its mission and will stand down for the present. We look forward to receiving your comments.

Special Round Table Conference on Global Environment Problems (As of April 1, 2010)

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Former Auditor	Kiyoshi Tazawa	Former Auditor, Asahi Glass Co., Ltd.

Part 1
Today's Global Environment

Today's Global Environment

In recent years, news of receding glaciers, melting permafrost, and the decrease in Arctic sea ice have reached our ears, which could be said to indicate that mother Earth is beginning to face various unprecedented abnormal changes. And further, when we hear of the increase in large natural disasters such as droughts, heat waves, heavy rains, floods, and large hurricanes across the globe due to disturbances in the balance of normal weather patterns, we must ask ourselves, is something wrong or different from the past?

When we look at the entire globe, it becomes even clearer that these phenomena and changes in the climate are large and growing in seriousness; and there is a high probability that these abnormal changes are induced by human activities.

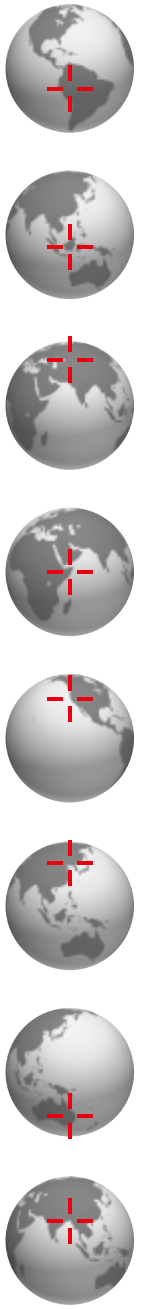
It is said that economic development accompanied by mass consumption of fossil fuels has increased the level of greenhouse gases in the atmosphere, leading to a rise in average global temperature, resulting in global warming. This global warming is said to have brought the extreme climate change and to be the cause of various natural disasters, which in turn could accelerate food and water

shortages, and eventually increase the number of refugees across the world.

On the other hand, the global population has been increasing sharply, and in order to meet the increased demand for food, there is a further need to develop land for agriculture and pasture. Irrigating land not suitable for farming is causing our rivers and lakes to dry up and is resulting in the depletion of groundwater reserves. Moreover, land development is reducing the area of tropical rainforests. The loss of these rainforests which are said to be the "lungs of the Earth" and "cradle of life" will not only hasten the destruction of the local ecosystems, but will also extend its effect to Earth's climate globally.

The crisis the global environment is facing is often somehow obscured by the benefits brought about by economic growth. We are also busy with the tasks of our daily life and tend to forget to take notice of the situation.

Nonetheless, if we do not act to rescue the Earth from its present crisis, the global environment, which provides us with the foundation for our lives, will be damaged irrevocably. We would like you to first understand what really is happening to the Earth today.



"The Lungs of the Earth" destroyed by human activities

Loss of biodiversity accelerated

Water resources disappearing from the Earth

Well-fed countries and starving countries

Fossil fuels heading towards depletion

Rapid increase in energy consumption

Record-breaking droughts hitting grain-growing regions

Rapid increase in "climate refugees" in developing countries

Eastern part of the state of Acre, Brazil / Amazon rainforest increasingly destroyed

In the eastern part of the state of Acre, which is the forefront of development in the region, land is being converted into sugarcane fields to produce bioethanol, which has recently become more popular as an alternative fuel. Various elements interacting are causing recent deforestation and they are not easy to define, as compared to the large-scale development projects that were the major cause in the 1970s and 1980s.

The "Lungs of the Earth" Destroyed by Human Activities

Thirty percent of the land area on Earth is covered by green forests extending over 40 million square meters in total. However, the area occupied by these precious forests has been rapidly decreasing in recent years.

According to the Untied Nations Food and Agriculture Organization (FAO), a total of 73,200 square meters of forest was lost during the period from 2000 to 2005. This means that a forest area equivalent to around 20 percent of Japan's land area is lost every year.

The major reason why the forested areas continue to decrease is human activities, such as large-scale felling of trees for timber, clearing for pastureland and farmland, and slash-and-burn agriculture.

Among the many types of forest thus disappearing across the globe, the loss of tropical rainforest poses a particularly serious problem.

It is said that the rainforests of South America, Southeast Asia, and the central part of Africa alone produce about 40 percent of oxygen generated on Earth.

In particular, the Amazon rainforest that extends over the Amazon River basin is thought to produce about one quarter of the Earth's oxygen, and this is why the Amazon forest is known as the "lungs of the Earth."

Every year, however, 20,000 to 30,000 square meters of Amazon

rainforest are lost against the backdrop of an increase in the global demand for food.

In Brazil, which is a major producer of meat and soybeans, from the late 1980s, the rainforest of the Amazon River basin has been burned down and turned into pastureland. Accordingly, the number of cattle raised in Brazil increased by 42 million over the period from 1994 to 2007, and at least 80% of these were in the Amazon River basin. Moreover in recent years, more and more rainforests have been turned into fields to grow soybeans, corn, and sugarcane, due to the increased demand for soybeans for feed and demand for bio-fuels.

To curb this trend, the Brazilian government strengthened its law enforcement capability by introducing a satellite forest monitoring system and thus the frequency of illegal tree felling has decreased over the past several years. However, trees in the rainforests are still being felled indiscriminately to create farmland and pastureland. To produce the food we consume, the rainforests continue to be destroyed.

If nothing is done to remedy the situation and the deforestation of the rainforests does not cease, within several decades we could lose the entire Amazon rainforest, which serves as the Earth's lungs. Moreover, deforestation may potentially have a serious impact on global climate change.

Accelerated Loss of Biodiversity

Rainforests in the Amazon and other areas are rich in biodiversity. At present, it is estimated that there are as many as 50 to 100 million species living on the Earth, of which only about 1.6 million have been identified. Among those, about 50 to 90 percent are said to live in the rainforests, which accounts for only seven percent of the Earth's area.

The decrease in rainforests, which are rich in ecosystems, will directly lead to a mass extinction of wildlife and is accelerating the loss of biodiversity.

Even in the rainforests of Southeast Asia, rapid extensive logging has taken place recently. On the island of Borneo, located in the middle of the region, forests which used to cover 95 percent of the island have now decreased to around 50 percent. Because of this, orangutans, which only live on the islands of Borneo and Sumatra, are now in danger of extinction.

The major reason why the orangutan population is decreasing is the construction of oil palm plantations in Borneo and Sumatra. Palm oil extracted from oil palm is used as cooking oil, an ingredient in cosmetics, and as a material for cleaning agents that do not pollute oceans and rivers as synthetic detergents do. In recent years, the demand for its use as bio-fuel has increased with its low CO_2 emitting potential. To mass produce oil palm for "earth friendly palm oil," in Borneo and Sumatra, rainforests are being turned into oil palm plantations. As a result, about 80 percent of

The island of Borneo, Indonesia/Orangutans in danger of extinction

At present, the numbers of orangutans are estimated to have dropped below 7,000 in Sumatra and to less than 55,000 in Borneo which is twice as large as Japan. But even in the national parks, rapid deforestation and increased poaching are continuing, making further estimates in the actual number of orangutans fall even lower.

the orangutan habitat has disappeared over the past 20 years. If the forests continue to be felled at the present pace, orangutans will become extinct in 20 years.

In addition to tropical rainforests, the lakes, ponds, moors, tidelands, and paddy fields around us are also rich in biodiversity. However, these wetlands are rapidly being lost all over the world to land reclamation projects to create land for farming and industry.

The Earth is now entering into its sixth mass extinction period. When the last mass extinction occurred 65 million years ago, many dinosaur species became extinct. However, the danger of mass extinction which the Earth is now facing is far different from those the Earth faced in the previous five periods, as those in the past were caused by changes in the natural environment, but it is we human beings who are causing the present crisis.

The rate of extinction is also much faster. The present extinction rate is about 1,000 times faster than that prior to the modern age, meaning that 40,000 species become extinct every year.

We are thus in a period of mass extinction, and the Earth's biodiversity is being seriously threatened.

Water Resources Disappearing from the Earth

The Earth is a blue aquatic planet. But 97.5 percent of its water lies in the oceans and is saline, which in turn means that freshwater resources available for human beings account for only 0.01 percent of all the water on the planet. We rely for our existence on this limited water supply.

These precious water resources, however, are rapidly being depleted due to human activities, and people are suffering from water shortages all across the globe.

The Aral Sea, which lies between Kazakhstan and Uzbekistan, used to be a salt lake full of water into which the Amu Darya and the Syr Darya rivers drained. There was no outflow from this huge salt lake and with its vastness was called a sea. It was the fourth largest lake in the world extending over 66,000 square kilometers, equivalent to the size of Hokkaido, the second largest, most northern island in Japan.

The fishing industry prospered with catches from the Aral Sea amounting to about 60,000 tons per year. The local inhabitants felt blessed by nature.

The Aral Sea provided an oasis in central Asia, helping to keep temperatures and humidity at stable levels and maintaining a diversity of both animals and plants in the region. However, now the lake is in danger of disappearing, not by the end of the century, but in the next 10 years.

It was a minor change they thought at the time. Diversions were made to rivers flowing into the Aral Sea. In the 1950s, the former Soviet Union started a large project to divert the rivers to irrigate the desert to produce wheat and cotton. As a result, cotton production in Uzbekistan increased from less than 1.5 million tons in the 1940s to five million tons in 1986. It seemed like a symbol indicating that mankind could benefit by changing nature. However, from the 1960s, the amount of water flowing into the lake from the freshwater rivers began to decrease, and accordingly the water level of the lake began to drop.

The depletion of water resources generates a vicious circle. In this case, as the water level in the salt lake lowered and the lake started to dry up, rainfall decreased and the amount of water flowing into the lake started to drop steadily. Desertification followed with local vegetation and trees dying and surface soil lost, which further accelerated the desertification of the area. The salt concentration in the lake water got higher and the cotton fields began to suffer salt damage. It became impossible to grow cotton and most of the living beings in the vicinity of the lake also died, and the fishing industry collapsed. The area began to be hit by sand storms that covered some local towns and that made it impossible for inhabitants to continue to live in the area. The area around the Aral Sea thus became a “dead town.”

Over the 50 years since the implementation of the irrigation project, the Aral Sea, an area the size of Hokkaido, has shrunk to a salt desert in the surrounding area. Ten years from now, only 60 years after humans changed the natural cycle, the lake may finally disappear altogether.

In order to preserve our water resources, we must recognize that it is necessary to keep a good balance on its supply and demand by devising and implementing appropriate measures. It is very difficult to regain that balance once it is disturbed. Therefore, people of all regions are required to maintain a balance between supply and demand in their use of water and ensure that the water quality is maintained.

The Aral Sea in Central Asia/Comparison between 1989 (photo on left) and 2008 (photo on right)

The Aral Sea has been shrinking since 1960. In 1989 it was separated into two parts (the northern part called “the Small Aral Sea” and the southern part called “the Large Aral Sea”). Subsequently, around 2005, the Large Aral Sea was again separated into eastern and western parts. The shrinking of the lake and the resulting drastic changes in the local environment, all the result of human activities, are said to represent the largest example of environmental destruction in the 20th century.

Well-Fed Countries and Starving Countries

The annual world production of cereals amounts to about two billion tons. If this amount were distributed to all the people around the world as primary food, the per-capita quota per year would be 340 kilograms. This amount is enough to feed about 13 billion people and therefore should be sufficient to support the lives of the approximately 6.8 billion people currently living in the world.

If that is the case, why are there still so many people starving in the world? The fundamental reason for this is that populations are increasing only in specific regions and resources are distributed unequally across the world.

You need four kilograms of corn feed to produce one kilogram of chicken. For one kilogram of beef, it will be 11 kilograms of corn feed. When people eat more meat, instead of eating cereals and soybean directly, the overall consumption of cereals increases substantially.

Both in the developed countries and emerging economies, when economic development takes place, people radically shift their eating habits from eating cereals as the primary food to eating more non-staple foods including meat. For example, Japan imports 10 percent of the wheat produced in the world. Although 30 percent of this imported wheat is consumed as food, nearly 70 percent of it is used for livestock feed. Although everyone in the world could be fed if crops were distributed equally across the world, the reality is different with a gap being generated: people in some regions get

Somalia, Africa/Starving children

Somalia is one of the poorest countries in the world and the malnutrition rate among the children there is very high. The country has large numbers of refugees from its civil wars, and with the lasting drought, more than half of all livestock has died in many of the regions and the production of cereals has dropped by more than half. The number of people who have access to safe water is very low at below 30 percent.

more and those in other regions get less.

According to a survey conducted by the FAO, the number of people starving in the world in 2009 is estimated to exceed 1,020 million, up around 100 million on the previous year. We are in the worst age of "serious starvation"; one in six people in the world is starving.

On the other hand, people in developed countries are devouring as much as they want in an unprecedented manner.

In Japan, which is the world's largest single importer of agricultural products, people are eating much more meat and eggs than before and continue to take in high-calorie high-fat meals while worrying about obesity.

The situation is the same with seafood. For example, the quantity of shrimps imported into Japan has increased by 100 times compared with about 40 years ago and now the Japanese consume one-third of all the shrimps harvested in the world. Because the demand cannot be met with shrimps caught in the sea, mangrove trees in Southeast Asia have been felled to create ponds to cultivate shrimps.

Moreover, Japan imports 58 million tons of food every year but is said to waste one-third of that amount (about 19 million tons), an amount that could feed about 55 million people.

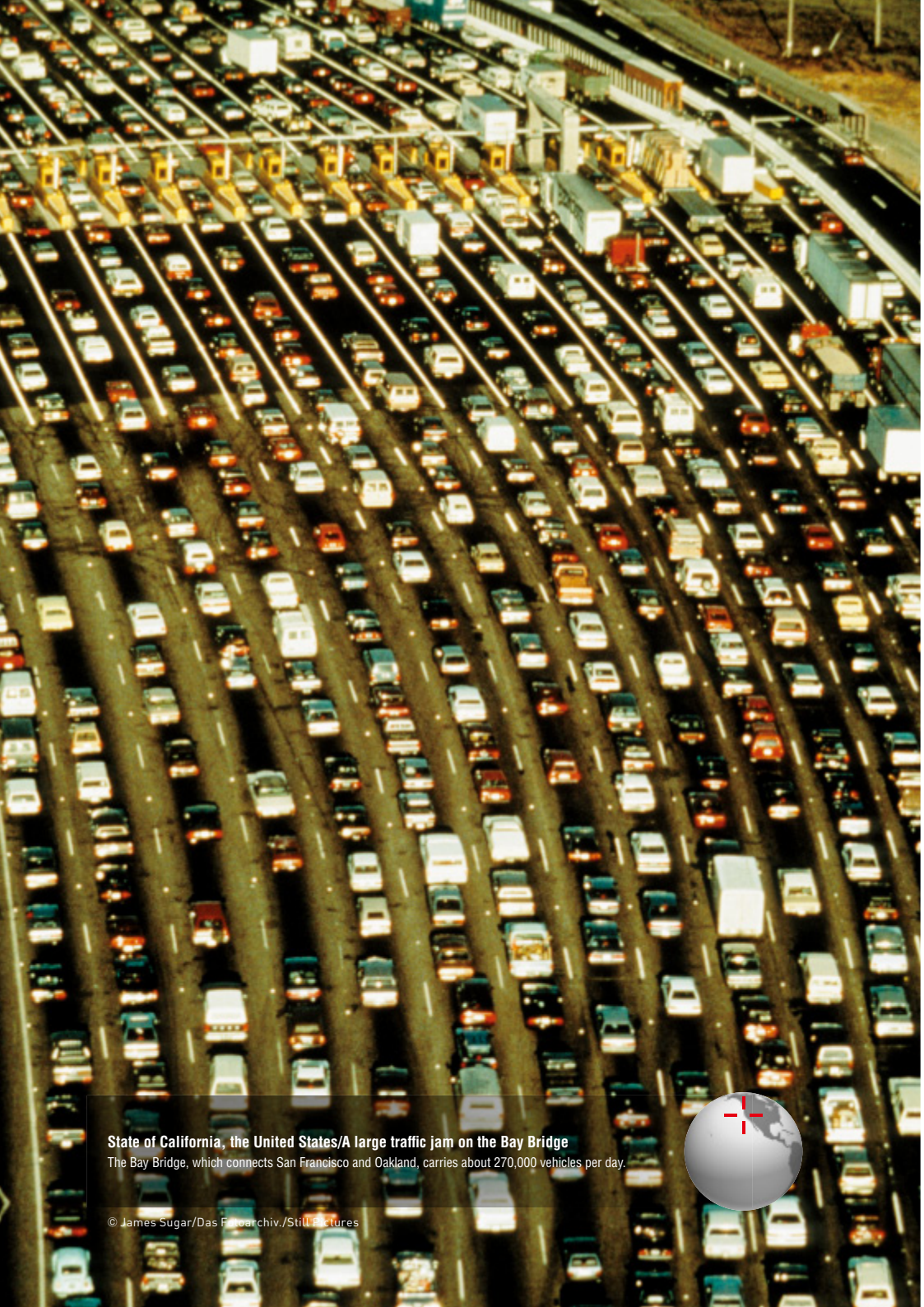
While the gap is widening for the availability of food, decrease in crop yields due to abnormal weather and droughts caused by global warming, and huge price hikes in food caused by the use of cereals to produce bio-fuels, may further contribute to increasing the number of people starving.

Depletion of Fossil Fuels

Oil, coal, and natural gas, which at present form our main energy sources, are produced from living beings that existed on Earth long before the emergence of mankind. The organic matter produced with solar energy and stored in those prehistoric creatures has been chemically altered by pressure and heat, and thus is called "fossil fuel."

Human beings made a tremendous leap in developing civilization following the Industrial Revolution helped by mass consumption of these fossil fuels. In the 18th century, the invention of the steam engine, which triggered the Industrial Revolution, made coal the dominant fuel of the age. Subsequently, at the end of the 19th century, internal-combustion engines (e.g. gasoline-powered engine) were invented and automobiles were commercialized. Then the airplane was invented. In the 20th century, humans began to consume oil on a massive scale, and coal- and oil-thermal power generation was widely adopted to create the foundation of our present society.

The United States is a typical example of this. The country accounts for only four percent in world population, but its CO_2 emission accounts for 30 percent of the worldwide total. It is also a resource-rich country, having one of the highest fossil fuel reserves in the world. It may have been this abundant domestic supply of resources, that enabled the country to build a social structure and develop a lifestyle that consumes a vast amount of energy.



State of California, the United States/A large traffic jam on the Bay Bridge
The Bay Bridge, which connects San Francisco and Oakland, carries about 270,000 vehicles per day.

Of all the countries in the world, the United States in particular consumes the largest amount of oil per day, accounting for about a quarter of the world's daily oil consumption. Nearly 70 percent of this amount is used as fuel for trucks, buses, and automobiles. The United States is the home of the automobile industry, and its transportation network, which relies on roads, extends over the whole nation. Life in the United States cannot be sustained in its present form without this mass consumption of oil.

At present, however, all countries including the United States are facing the need to move away from a fossil fuel-based society. It is estimated that oil reserves will be exhausted in around 40 years, natural gas reserves in around 60 years, and coal reserves in around 120 years. If we continue to rely on fossil fuels, we will not be able to keep up with the increase in the world's energy demands and we might have to face a serious depletion of our natural resources in the not too distant future.

Use of renewable energy sources such as solar, thermal, wind, hydraulic, and geothermal power and biomass will not increase the concentration of CO_2 in the air and they are available as long as the Sun continues to shine. But compared to fossil fuels, it is difficult to have a large amount of energy output from solar power and wind power and they are unstable. How to ensure a stable supply from these renewable energy sources remains a challenge.

We will not be able to solve the energy problem only by shifting to use cleaner energy, but we also need to change the way we currently consume energy. We need to review how we use energy to support our lifestyles if we are to reduce the impact we have on the global environment.

Liaoning Province in China/China's largest iron and steel works in Anshan

The production of iron and steel form the basis of a country's strength and industrial might. In 1996, China became the world's top producer of iron and steel, outstripping Japan. The country has been increasing production and now China accounts for about half of the world's iron and steel production.

Rapidly Increasing Energy Consumption

While there are concerns about the depletion of fossil fuels such as oil and natural gas, China and India with large land areas and huge populations, are continuing their rapid economic growth in Asia. Particularly China, blessed with coal and natural gas resources, is rapidly increasing its consumption of resources and energy.

In China, the consumption of primary energy increased from 961 million tons (in oil equivalent) in 1997 to 1,863 million tons in 2007, almost doubling in a decade. And accordingly, China's CO_2 emissions which were only around half the level of the United States in 2000, increased and China is now the largest emitter of CO_2, outstripping the United States in 2007.

In China, the industrial sector accounts for 70 percent of the country's total energy consumption. China has been soliciting foreign companies to operate in the country by providing cheap labor and land, and with these measures it has developed into a "world factory." The country has thus been expanding its industrial production through the mass consumption of energy. When seen from a different viewpoint, it could be said that Japan and other countries who import cheap goods from China are letting China emit CO_2 on their behalf for the energy used for their production.

Economic growth driven by industrialization has raised the living standards of the people of China.

In 1980, there were 1.87 million vehicles in China and in 2005 that number increased 18-fold to 32 million vehicles and will continue to increase. The use of household electrical goods has been also expanding: In urban areas, there were only around 30 air conditioner units per 100 households in 2000, but this increased to 80 units in 2005 and the demand for electricity in the summer months has been rapidly increasing.

Present China looks to be in a similar position as Japan was during its high economic growth period from the 1950s to 1970s. In pursuing economic growth, China is following the same path as that taken by the developed countries in the past, namely a resource-wasting inefficient production and consumption style. Although as such, developed countries cannot force China to move in step with them in tackling the issues concerning depletion of resources and global warming.

However, if countries continue with their mass consumption of fossil fuels for economic growth as they have done in the past, life on Earth will not be sustainable. At present, per-capita CO_2 emission in China is less than about one-fifth the level of the United States and about half the level of Japan. If China and India with their huge populations, choose to continue their energy-hungry mass-production and mass-consumption lifestyles, our fossil fuel reserves will soon be depleted and we will find ourselves in a global environment that is damaged and unable to recover from global warming and pollution.

The Asian region, which has seen a remarkable economic growth in recent years, has become the world's largest emitter of CO_2 and holds the key to the success of future anti-global warming measures. On the other hand, the developed countries must fundamentally review their past resource-wasting, mass-producing, and mass-consuming habits and own the responsibility to shift to sustainable production and consumption. On that premise, developed countries, countries that are now entering a period of economic growth, and countries that will develop in the future must cooperate in solving these common problems faced by the whole of mankind.

Record-Breaking Droughts Hit Grain-Producing Regions

Global warming does not simply mean higher average temperatures on Earth. It also brings with it a range of climate changes. In particular, the greatest concern is the widening gap in the level of precipitation among different regions of the world. In regions where the rainfall is already low, precipitation is further decreasing, causing droughts and desertification.

Australia is an agricultural country, and agricultural exports account for nearly 25 percent of its total export value and it is the third largest wheat exporter following the United States and Canada. Japan imports a wide range of foods from Australia, including wheat, barley, rapeseed oil, and beef.

The annual precipitation in the country had been about a quarter of that of Japan, but since the latter half of the 1990s that amount decreased. Then in 2002, the country suffered a severe drought and as a result, cereal production dropped to almost half the usual annual amount.

Since then Australia has continued to suffer from water shortages. In 2006, it was hit by a "once-in-a-thousand-years drought" and in 2007 water levels in the Murray-Darling River running through the southeastern part of the country dropped, and the basin was hit by an unprecedentedly severe drought. The Australian government implemented measures to support farmers, but many of them lost the source of their income and went bankrupt: some even committed suicide. This issue posed a serious

State of Queensland, Australia/Marshlands crack with the drought

In the Murray-Darling basin area, which accounts for 41 percent of the country's agricultural production, yields sharply decreased because of the serious drought. In the State of Queensland where people are suffering from a serious water shortage, the government is regulating water consumption.

social problem.

Moreover, the fall in the production of wheat in Australia caused a rise in international wheat prices.

It is predicted that Australia will continue to suffer from decreases in the level of precipitation. In February 2009, a series of mountain fires broke out and devastated forests over a wide area in the dry southeastern part of the country, with more than 200 people losing their properties and wildlife habitats destroyed. The fires were the worst the country had experienced.

Global warming has brought radical changes to the weather patterns that people have adapted to over many years.

The heat waves that hit Europe in 2003 killed 35,000 people and caused 15 billion dollars worth of damage to local agriculture. Subsequently in 2006 the region was again hit by heat waves, and in 2007 the southeastern part of Europe and the Mediterranean region suffered abnormally high summer temperatures. As in Australia, precipitation levels also dropped in Central Asia and Africa, and in these regions desertification is expanding following droughts.

Against these abnormal weather patterns, conventional disaster control infrastructures and systems tend to be ineffective in controlling large-scale natural disasters. We cannot be ignorant about abnormal weather patterns and natural disasters as they pose a threat to all of us at any time.

Rapid Increase of "Climate Refugees" in Developing Countries

Due to climate change, regions which had large precipitation levels are receiving even larger amounts of rainfall, and cyclones (typhoons) and hurricanes tend to be larger in size. As many of you still remember, in 2005 a massive hurricane named Katrina hit New Orleans in the United States, devastating the city.

The mega-deltas of Asia, such as those located in the furthest downstream areas of the Ganges and Mekong, are particularly vulnerable to damage by heavy rains and large cyclones. For example, Bangladesh which is affected by the Asian monsoon has 90 percent of its land area in the delta, and its people have been engaged in farming that follows the natural cycle of seasons, with floods in the rainy season helping to fertilize the land. In recent years, however, damage from floods has become so severe that people's livelihood and their lives themselves are threatened.

In 1998, Bangladesh was hit by the so called worst ever flood in the country's history. Just looking at the eight years from 1990 to 1998, the country was hit by three storms, four floods, one tsunami and two cyclones, with more than 400,000 people killed and more than 42 million suffering. Again in November 2007, a cyclone hit the country bringing strong winds, heavy rain, and high tides. More than 5,000 people died and at least 900,000 people lost their homes.

It is thought to be climate change caused by global warming that is making the floods more serious and long lasting.

Dacca, Bangladesh/Flooded capital of Bangladesh

Two-thirds of the nation was flooded in a serious flood that hit the country in July 2004, and the city of Dacca, one of the most densely populated cities in the world, was also flooded. Natural disasters including floods are causing streams of people to flow into Dacca to escape poverty, and as a result, many of them are living in terrible conditions.

In Bangladesh, about 80 percent of the population live in rural areas and are engaged in small-scale farming. Floods do not kill as many people as cyclones do, but they deprive farmers of almost all of their agricultural products, livestock, houses, and other property, forcing them to sell their land to survive. These people who have lost the very means of living become "disaster refugees" and move to urban areas to find jobs. In the capital Dacca, the population increased from 6.48 million in 1991 to 9.91 million over the 10 years to 2001. At present, it is estimated that the municipal population exceeds 15 million.

In Sudan, Nigeria, Chad, and other countries in sub-Saharan Africa, people have been suffering serious famines brought on by droughts caused by climate change, and 10 million or more people have become refugees in search of food. In the Philippines, floods began to hit the country more often than before as a result of deforestation, and more than four million people have moved to higher land to escape flood damage.

As mentioned here, the severity of natural disasters has thus increased the number of people who are forced to leave their farms and homeland and become refugees, particularly in the "southern" countries of the North-South divide.

Damaging Nature Means Damaging Ourselves
—What is Our Choice

The phenomena we have described here seem to take place randomly in various places around the world, but they are actually interrelated.

Mankind forms a part of the global environment, and can be said to be a part of nature, thus meaning that damaging nature is equivalent to damaging ourselves. However, among the diverse living beings on Earth, only humans have continuously increased in number while wreaking great changes on the environment at the cost of other living beings. Even worse, we have been pursuing economic growth without recognizing what kind of effect our activities have, and as a result have seriously damaged the balance of the natural environment and its ecosystems, and brought about global warming.

As described in the preceding sections, global warming is interrelated with various problems that are emerging in individual countries and/or occurring extending beyond national boundaries, such as those related to energy, global warming, distribution of food and water resources, destruction of the natural environment and loss of biodiversity, the economic gap between urban and rural areas, demographic movement, and poverty. If one of them becomes worse, that will influence other problems to become worse, making it even more difficult to solve them. These problems thus form a vicious circle and a so-called negative chain. Under these circumstances, the present global environment is moving in an unprecedentedly dangerous direction.

Since the beginning of the Industrial Revolution, developed countries have achieved economic growth at great cost to the Earth. At present, emerging economies with their large populations are following the same path. Unless we stop imposing further heavy burden on Earth, cease pursuing short-term benefits, cut the negative chain of misfortune, and choose to lead a new and fulfilling lifestyle that is in harmony with nature, mankind will not have a bright future.

As a first step, we must put our efforts into confirming what the present situation is and consider what each of us can do to cut the negative chain that will lead to catastrophe, and then let us each move in the direction of taking appropriate actions.

Part 2
Conditions for Survival

Chapter 1

The Largest Crisis Ever Faced by Mankind

—Global Environmental Problems

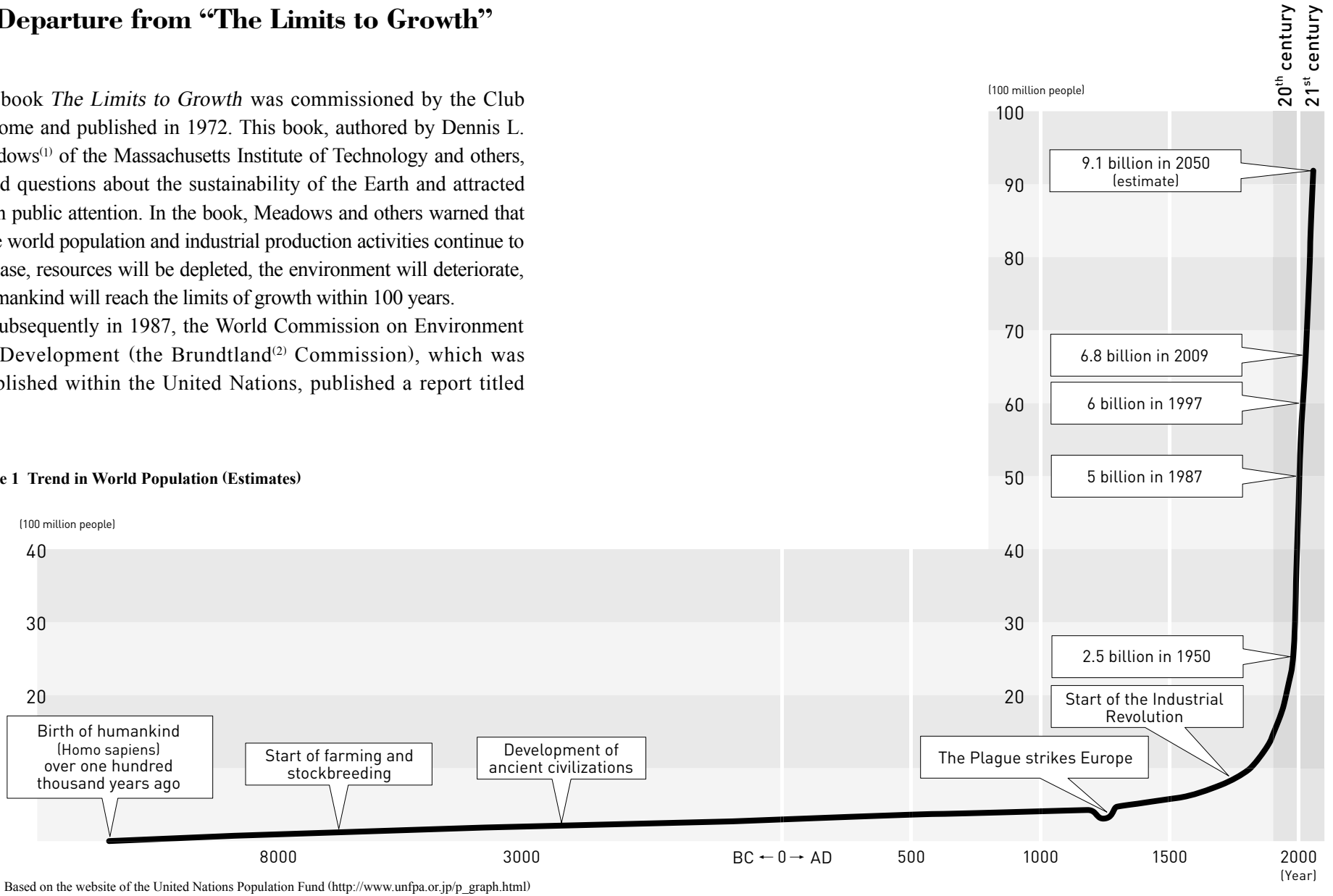
The Industrial Revolution took place in Europe in the 18th and 19th centuries and economic development spread across the world, led by industry. Since then mankind has pursued a life blessed materially through developments in science and technology and the market economy. But on the other hand, as a result of our consumption of fossil fuels on a massive scale, emissions of CO_2, which is a greenhouse gas, have rapidly increased. Mankind has to date prioritized economic development, and as such, it has to be said, has been ignorant about what impact its activities would have on nature, which provides the basis for its survival. Although scientists began warning that nature, the foundation for the survival of mankind, was already being damaged at the end of the 20th century, mankind continued to prioritize economic development, and as a result mankind is now facing a crisis caused by global environmental problems.

1 Departure from "The Limits to Growth"

The book *The Limits to Growth* was commissioned by the Club of Rome and published in 1972. This book, authored by Dennis L. Meadows[1] of the Massachusetts Institute of Technology and others, raised questions about the sustainability of the Earth and attracted much public attention. In the book, Meadows and others warned that if the world population and industrial production activities continue to increase, resources will be depleted, the environment will deteriorate, and mankind will reach the limits of growth within 100 years.

Subsequently in 1987, the World Commission on Environment and Development (the Brundtland[2] Commission), which was established within the United Nations, published a report titled

Figure 1 Trend in World Population (Estimates)



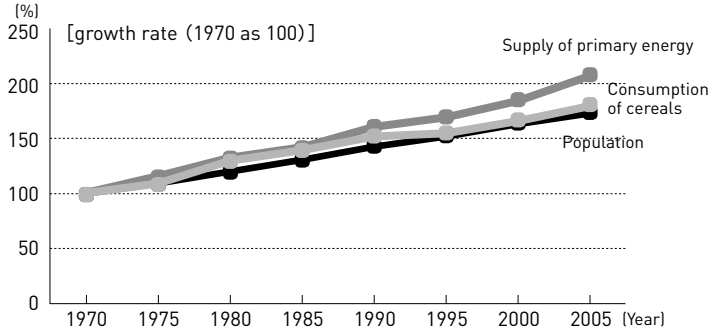
Source: Based on the website of the United Nations Population Fund (http://www.unfpa.or.jp/p_graph.html)

Our Common Future. In this report, the Commission proposed the concept of "sustainable development" as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This concept implies that it is necessary for mankind to continue to have economic growth to solve the poverty problem but that growth should be achieved, unlike in the past, in a sustainable manner. The concept then spread internationally through the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, the World Summit on Sustainable Development held in Johannesburg in 2002, and other international conferences.

When we look at the transition of world population from several hundred thousand years ago, we can see that the increase since the beginning of the Industrial Revolution (Fig. 1) has been exponential. It continued to increase year by year even after the publication of *The Limits to Growth,* and has increased by about nearly 1.8 times over the 35 years from 1970. Energy and food consumption have also been on the rise at a rate exceeding the growth rate of the population (Fig. 2 and Table 1).

The ecological footprint,[3] one of the indicators of the global

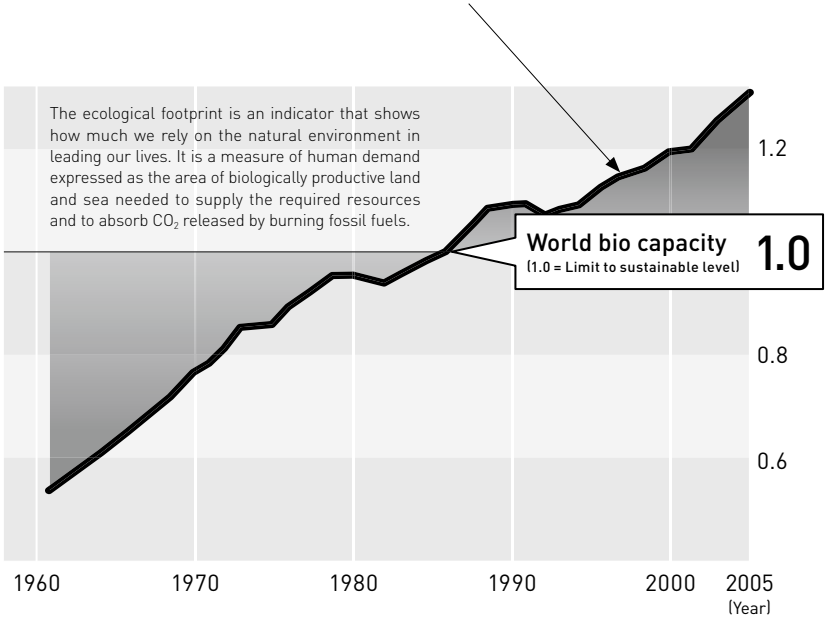
Figure 2/Table 1 Trends in World Population, Supply of Primary Energy and Consumption of Cereals (1970 onwards)



		1970	1975	1980	1985	1990	1995	2000	2005
Population	1 million people	3,686	4,061	4,438	4,846	5,290	5,713	6,115	6,512
	Average annual growth rate	—	2.0%	1.8%	1.8%	1.8%	1.5%	1.4%	1.3%
Supply of primary energy	1 million toe*	4,970	5,771	6,630	7,153	8,095	8,538	9,263	10,555
	Average annual growth rate	—	3.0%	2.8%	1.5%	2.5%	1.1%	1.6%	2.6%
	Per-capita consumption (toe/person)	1.35	1.42	1.49	1.48	1.53	1.49	1.51	1.62
Consumption of cereals	1 million tons	1,108	1,212	1,440	1,553	1,707	1,739	1,860	2,021
	Average annual growth rate	—	1.8%	3.5%	1.5%	1.9%	0.4%	1.3%	1.7%
	Per-capita consumption (tons/person)	0.30	0.30	0.32	0.32	0.32	0.30	0.30	0.31

*toe: ton of oil equivalent
Source: Based on World Population Prospectus, UN, BP Statistical Review of World Energy 2007 and data on the demand, production and term-end inventory rates of cereals prepared by the Japanese Ministry of Agriculture, Forestry and Fisheries
Notes: —Cereals include rice, maize, wheat and barley. —The average annual growth rate means the average annual growth rate over the previous five years (e.g.: the five years from 1970 to 1975 for the average annual growth rate for 1975).

Figure 3 Trends in the Ecological Footprint of Humankind



Source: Based on Living Planet Report 2006, WWF

environmental impact of human socioeconomic activities, shows that by the middle of the 1980s mankind had already consumed resources at a pace faster than the Earth's ecological capacity can regenerate. The latest data (2005) also indicates that the resources we are consuming and the amount of waste we are generating from our activities have exceeded the level that the Earth can provide and can absorb in a sustainable manner by nearly 30 percent (Fig. 3).

The underlying factors that lie at the root of the global environmental problem are the rapid increase in population and economic development. The issue of population control is fundamentally related to religions and social systems of individual societies and cannot be discussed simplistically. However, in considering global environmental problems, it is important to recognize that problems occurring on a global scale, including those related to food, water shortages, resources and energy, global warming, and loss of biodiversity, are closely connected to the problem of population increase.

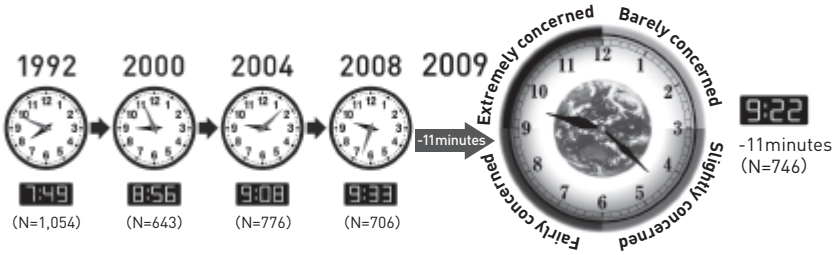
Mr. Lester R. Brown,[4] who won the Blue Planet Prize in 1994, insists on the need for population control in solving problems related to poverty, the environment, and resources. Increases in population and poverty are interrelated, and Mr. Brown says it is vital to implement measures to stabilize the world's population if we are to overcome poverty.

In the history of the developed countries, the spread of education and improvements in the status of women have proved to be important factors in stabilizing population growth. These factors are indeed essential for people to get out of poverty. In the developed countries, as economic situations have improved, education has been promoted and the status of women has been improved. In this regard, developing countries where populations are increasing could learn from the experience of the developed countries in solving related problems.

The Asahi Glass Foundation conducts an annual survey[5] on the sense of crisis felt by respondents for the survival of humankind in the global environment that continues to deteriorate, targeting experts throughout the world. The Foundation has been monitoring their responses over time as indicated by the hands on the Environmental Doomsday Clock it created (Fig. 4). In the first survey held in 1992, the clock showed 49 minutes past seven, and through the years the clock has advanced. In 2009, the clock indicated 22 minutes past nine. This implies that the experts are extremely concerned about the accelerating deterioration of the global environment. If we are to solve the world's environmental problems, not only experts but also ordinary people must enhance their understanding of the present global environmental situation and start to set themselves in concrete actions.

In this book, we would like to try to bring insight to what we should do now, when the global environment is being irrevocably damaged

Figure 4 The Environmental Doomsday Clock Moves On



Source: The Asahi Glass Foundation

by human activities brought about by past economic development.

The first chapter is titled "Largest Crisis Ever Faced by Mankind," and in its second section, "Human Activities Facing Limits," we discuss those global scale crisis we can recognize in our daily lives, such as the present increase in the world's population, population concentrations in urban areas, loss of nature following industrialization, and excessive consumption and shortages in supplies of energy, water, and food resources. In the third section, "Crisis Creeping in," we will address problems related to global warming and loss of biodiversity, which are not easy to recognize in our daily lives but their influence would be extensive and serious. In this section, we emphasize that these problems are interrelated and once their impacts become significant, that will endanger the survival of mankind.

In the second chapter, "A Vision for the 21st Century," we propose to build a society based on the understanding of the current global environmental crisis described in chapter 1, in which human activities are conducted in harmony with the cycle of nature in order for mankind to survive sustainably. In this book we refer to this society as a "solar energy-based society." This proposal has its basis in the belief that human beings are nature's children and should support and live in concord with all other living beings within the constraints of nature.

In the third chapter, "Future Society Created by Overcoming Crises," we propose measures to achieve our vision of the society we describe in the second chapter. As an example of a resource, one that can be regenerated within the natural mechanism, and of energy, use of a solar energy is proposed.

Finally, in the last chapter we reconfirm the messages we want to convey throughout this book and draw some conclusions.

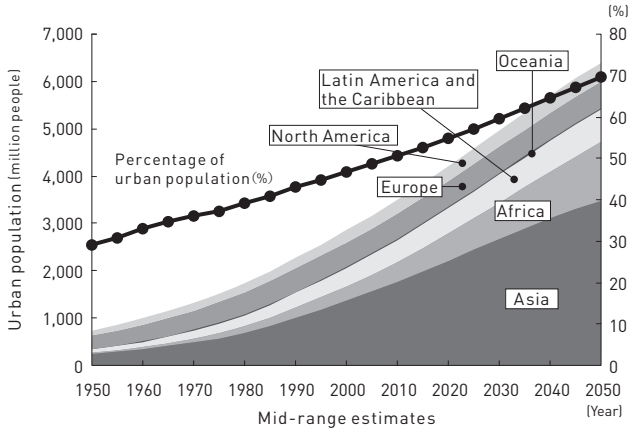
2 Human Activities Facing Limits

(1) Urbanization Sets Us Apart from Nature

People Concentrate in cities

Historically, with increased population, economic activities increased, and cities were built and grew in size with the progress of industrialization. The expansion of cities is expected to continue in the future, and in 2050 the urban population,[6] which currently exceeds 50 percent of the world's population, will account for 70 percent of the total (Fig. 5).

Figure 5 Urban Populations (Past Data and Forecasts)



*Definition of urban city is based on each country's criteria.

Source: Based on World Population Prospects: The 2006 Revision and World Urbanization Prospects: The 2007 Revision, United Nations

Cities Face Limits

Cities have played an important role in economic development because they are highly functional and efficient, but they are now coming up against limits in many areas.

When population concentration in cities becomes excessive over a short period, people suffer from shortages of employment opportunities and places to live, and cities themselves suffer from the need to maintain a good infrastructure. As a result, several problems emerge: traffic jams, deterioration of the living environment, increased poverty, environmental pollution, and an increase in crime. Air and water pollution will emerge as industrial facilities and motor traffic increases. In developing countries in particular, as companies cannot afford to bear the cost of environmental measures, environmental pollution worsens.

Cities are places where mass consumption of resources and energy and mass disposal of waste take place repeatedly, which could become a factor limiting urban growth. For example, domestic and industrial water supplies used in a city usually come from the basin in which it is located, and if the city gets its water supply in a way that has a bad effect on the local water circulation, this might prevent it from providing a stable water supply to its citizens. With excessive generation of waste, the waste remaining after the intermediate disposal process is sent to landfills, but the limited capacity of final landfill sites is becoming a problem. These problems are common to all mega-cities that are expanding under economic growth.

Cities have been overcoming the constraints of nature by replacing some of nature's functions with artifacts, but as described above, cities are at the same time vulnerable to the constraints imposed by the environment, resources, and energy. Mankind is thus confronting "limits to growth" not only because of environmental problems such as global warming, but also because of environmental pollution and constraints imposed on resources by the expansion of urban activities.

People are estranged from nature

While urbanization makes people's lives more convenient, the natural environment has changed greatly in many large cities as a result of expansion, leading to a decrease in the number of opportunities for people to come into contact with nature. As a result, humans, who lived and grew up surrounded by nature in the past are becoming more and more estranged from nature with the expansion of cities, and it is getting more difficult for them to recognize that they form a part of nature and are receiving many of her blessings.

At present with about half of the world's population living in urban areas, that will mean that about half of mankind is put in a situation where they do not have sufficient contact with nature. Shouldn't this be considered a serious crisis? Because, the vision to sense the importance of the value of nature will only come through continuous regular contact with the natural world, and where there is no nature around, the feeling that mankind is a part of nature cannot be nurtured and the will to acknowledge the importance of nature will gradually fade.

International initiatives for creating sustainable cities

In order to create a city where people come in contact with nature regularly, it is necessary to take a genuine thoughtful consideration of nature and transform our cities so that they harmonize with nature by overcoming problems such as environmental pollution

and the limits of resources. Initiatives are being launched by cities all over the world to make them eco-friendly. International activities are also underway, including those led by the United Nations Human Settlements Programme (UN-HABITAT), the International Council for Local Environmental Initiatives (ICLEI), and the United Nations Environment Programme (UNEP). Aiming to promulgate the creation of sustainable cities, these initiatives allow information on activities by local governments all over the world to be shared, human resources to be developed, and technical assistance to be provided. Moreover, the Asian Development Bank and the World Bank are giving financial support to boost investment in ways to improve the urban environment.

(2) Depletion of Energy Resources

Rising fossil fuel consumption

The Industrial Revolution which began in the 18th century brought about economic growth. This growth, led by industrial production, would not have been achieved without the use of energy resources such as coal, oil, and natural gas that existed in the natural world. The world's usage of primary energy has been on a continuous upward trend along with economic growth, and has almost tripled in the past 40 years (Fig. 6).

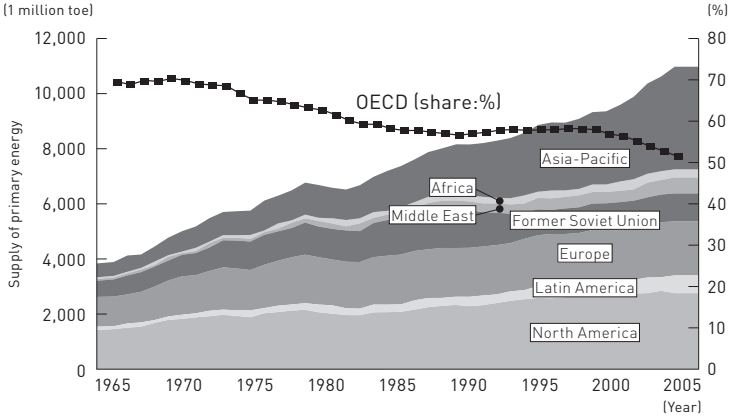
There are, however, substantial regional differences in the growth rates of this energy supply. While the rates have been on the decline in developed regions (OECD member states) that have achieved energy savings through industrial structure changes and improvements in efficiency of energy consuming machineries, the growth rates are on the rise in developing regions (non-OECD member states), which still need to establish economic infrastructures and grow their economies. In the Asia-Pacific region, in particular, there has been a substantial increase in energy usage.

Increasing energy consumption in developing regions

Increased energy usage in developing regions is largely attributable to their rapid economic growth. As shown in figure 7, while the world GDP growth rate has remained at around five percent since 2003, developing countries in the Asia-Pacific region have been achieving remarkable economic growth. China and India in particular have been showing a growth rate of around 10 percent, which coincides with the increase in the use of energy.

However, per-capita energy consumption is much smaller

Figure 6 Trends in World Supply of Primary Energy



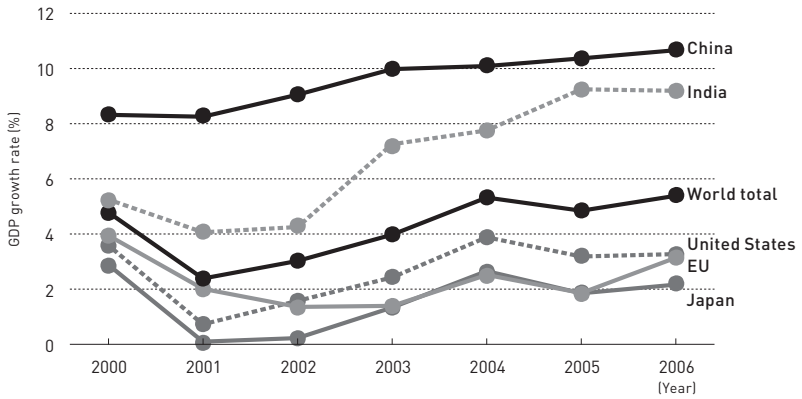
Source: Based on BP Statistical Review of World Energy 2007

in the developing regions as opposed to the developed regions (Fig. 8). If developing countries are to aim to follow the same economic growth path as that of the developed countries, there will be a major concern in that worldwide energy consumption will eventually swell to a level several times that of present.

Toward a sustainable use of energy resources

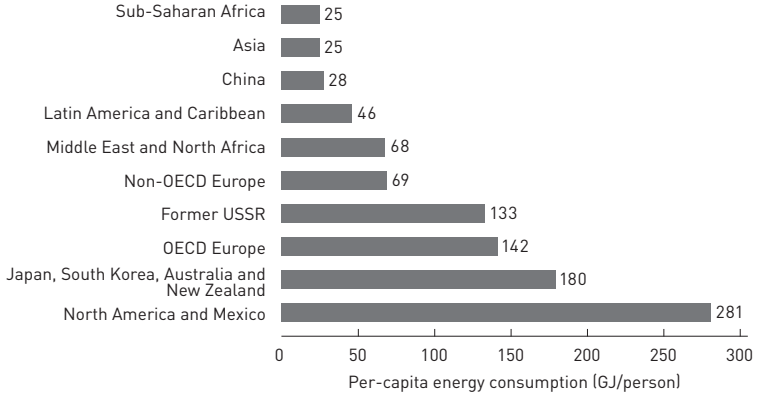
The expansion in energy consumption centered on the use of fossil fuels will lead to increased greenhouse gas emissions, which will in turn cause further global warming. This could also accelerate the depletion of resources whose reserves are limited. According to the past production of crude oil and liquefied gas and forecasts, production will reach a peak in around 2010 and then begin to decline (Fig. 9).

Figure 7 Trends in Economic Growth Rates



Source: Based on World Economic Outlook Database for April 2007, IMF

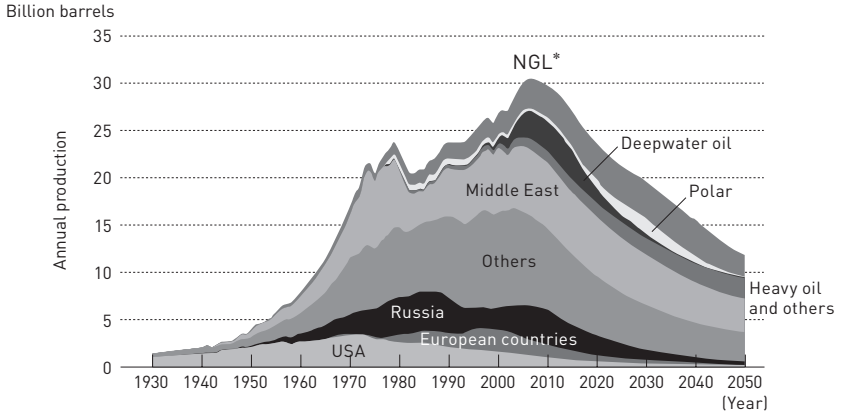
Figure 8 Comparison of Per-Capita Energy Consumption in Major Regions



GJ: gigajoule (equal to 10^9 joule)

Source: Based on World Energy Assessment 2004 overview, UNDP, 2004

Figure 9 Crude Oil and Liquefied Gas Production (Past Data and Forecasts)



*NGL: Natural Gas Liquid

Source: Based on Oil and Gas Liquids 2004 Scenario, Hubbert Peak of Oil Production website (http://www.hubbertpeak.com/Campbell/images/2004Scenario.jpg)

It is predicted that as developing countries achieve more growth, they will use more resources. But, developed countries cannot blame the developing countries for this. In the past, those same developed countries consumed vast amounts of energy and emitted high levels of CO_2 to achieve their growth, and developing countries also have the right to achieve growth in the same manner. Accordingly, the preface to the United Nations Framework Convention on Climate Change, states, "Recognizing that all countries, especially developing countries, need access to resources required to achieve sustainable social and economic development … their energy consumption will need to grow…."

Developing regions naturally have the right to achieve economic growth, but if the world continues to expand its use of fossil fuels as in the past, the depletion of resources will accelerate and global warming will pose an even larger threat.

In order for the world to achieve a sustainable use of resources and energy while allowing the growth of developing regions, it is essential that the developed regions save significant amounts of energy and shift from exhaustible energy sources such as fossil fuels to renewable energy. Developing countries are also required to stop pursing the mass-consumption lifestyles of the already developed regions and instead proactively introduce technologies and systems that will save resources and energy with a view to building a resource- and energy-recycling society where people can live in harmony with nature. The developed regions are expected to give their support to the developing regions for the technologies and capital required for their sustainable growth, and this support is essential for the sustainable use of resources and energy on a global basis.

International initiatives to ensure a sustainable use of energy resources

International initiatives to solve energy problems include the first summit meeting in 1975 of the Group of Six (G6), comprising the leading countries of the time, with their agenda to stabilize the world economy after the first oil crisis in 1973. At the summit meeting, participating countries confirmed the need to secure energy sources for economic growth and reduce dependence on energy imports by saving energy and developing alternative energy sources. After the 1980s, crude oil prices stabilized, but with the outbreak of the Iraq War in 2003, prices again began to soar. To deal with price hikes and also with the global warming problem, energy security became an important issue at the subsequent summit meetings.

Recently, at the meeting of the "G8 + 3"[7] Energy Ministers held prior to the 2008 G8 Hokkaido Toyako Summit, Ministers deemed the promotion of energy efficiency as one of the quickest and most cost-effective ways to address energy security and climate change while supporting economic growth and agreed to implement the IEA's[8] recommendations for promoting energy efficiency. Subsequently at the G8 Energy Ministers Meeting 2009, the International Partnership for Energy Efficiency Cooperation (IPEEC) was launched, which will create energy efficiency indicators, collect information about best practice, and conduct joint research on technologies for higher energy efficiency, thereby helping member states implement voluntary measures to increase their energy efficiency.

(3) Sustainable and Fair Use of Water Resources

Limited water resources

It has been estimated that the total amount of water on Earth is around 1.4 billion cubic kilometers. About 97 percent of it is seawater, and the remaining fresh water is stored mainly in the Arctic and Antarctic regions in the form of ice and glaciers. The amount of fresh water contained in groundwater, rivers, lakes, and ponds accounts for about 0.8 percent of the total, and most of this exists in the form of groundwater. The amount of fresh water contained in rivers, lakes, and ponds accounts for only about 0.01 percent of the total water on Earth.

Overall annual global precipitation amounts to about 577,000 cubic kilometers, of which annual precipitation on land comes to about 119,000 cubic kilometers. Of this amount, about 74,000 cubic kilometers are lost by evapotranspiration, 43,000 cubic kilometers stays as surface water, and the remaining around 2,000 cubic kilometers is stored as groundwater annually.

Water resources circulate over the land surface, air, underground, and oceans, and people make use of this water within the cycle. So, if we use water resources in a way that preserves the natural circulation, these resources will not be depleted. In reality, however, human activities are exerting a serious influence on the water cycle, which sometimes results in an uneven distribution of water resources.

For example, when forests are cut down for the purpose of land development, their contribution to the water cycle in protecting watersheds and reducing evapotranspiration is seriously interrupted. If these contributions are lost, flows in local rivers and groundwater levels will decrease, and may even have an impact on precipitation levels. In cities, the fact that the land is covered by artificial structures causes heat to be retained, and this in turn causes a rise in temperatures. This phenomenon, which is called the heat island phenomenon, rapidly changes local precipitation patterns and can result in disasters such as urban floods. According to the IPCC's[9] Fourth Assessment Report, the water cycle is affected globally by climate changes caused by global warming, and this in turn is predicted to increase average precipitations in tropical and high-latitude regions while decreasing them in semitropical and middle-latitude regions. Also, with these changes in the water cycle, while the general intensity of precipitation[10] will increase, inland areas will tend to have dry summers, which will increase the risk of drought.

Unequal distribution of water resources

Water is vital to sustain our lives and for the production of food, but water resources[11] are distributed unevenly through various regions of the world, depending upon factors that include climatic and geographical conditions. The water resources that countries have differ significantly by where they are located. For example, Vietnam has 2,708 liters of water resources per square meter per year, while Saudi Arabia has only 0.93 liters.

In addition to the uneven distribution of water resources attributable to climatic and geographical conditions, there are also social factors that prevent some countries from using their water resources efficiently, including the lack of social infrastructure needed to implement a water supply, and rapid increases in population, resulting in a shortage of drinking water for some regions. For example, as figure 10 shows, the number of people who have no access to drinking water is high in regions that include sub-Saharan Africa, East Asia, and South Asia.

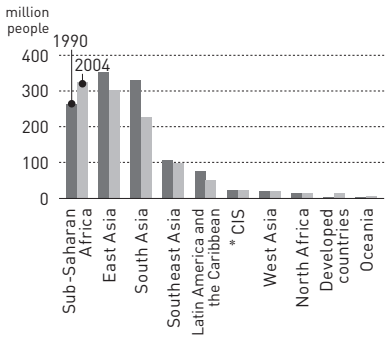
It is estimated that the number of people who cannot obtain a

sufficient supply of water will increase rapidly from now on and in 2050, the number of people facing water shortages will be more than five times that of 2005 (Fig. 11).

Worsening water shortages

The world's water consumption increased by about 2.7 times over the forty-five years from 1950 to 1995 and it is predicted that by 2025 consumption will further increase to about 1.4 times that of 1995. Of the total water consumption, 66 percent is used for agriculture and the demand for agricultural water is seen not to decrease much for the period up to 2025 (Fig. 12). Water consumption in Asia is larger than in other regions and will increase significantly in the future (Fig. 13).

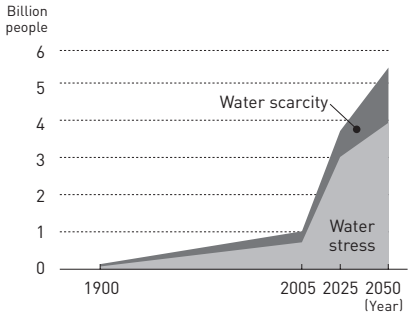
Figure 10 Regional Distribution of Population Who Have No Access to Drinking Water (1990 and 2004)



*CIS: Commonwealth of Independent States (12 countries from former Soviet Union)

Source: Based on data from the website of the Joint Monitoring Programme for Water Supply & Sanitation, WHO & UNICEF (http://www.wssinfo.org/en/231-wat-intro.html.Feb. 2007)

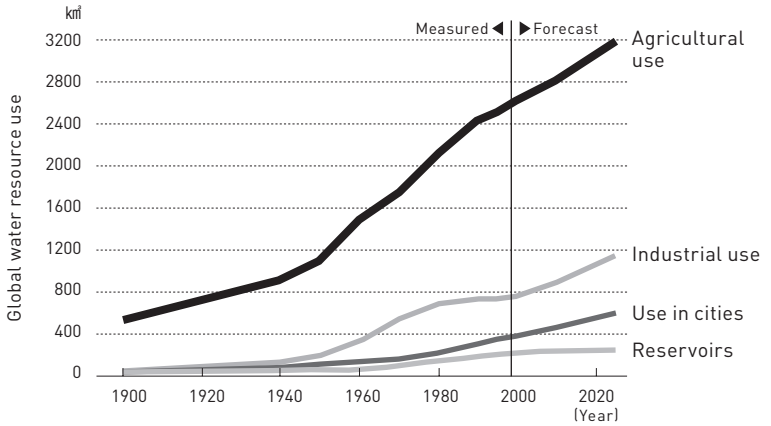
Figure 11 Population Facing Water Shortages



Water stress: less than 1,700 m^3/person/year
Water scarcity: less than 1,000 m^3/person/year

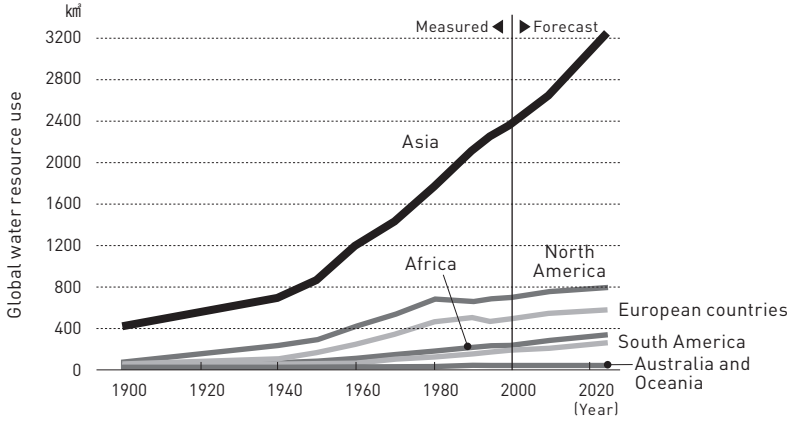
Source: Based on World Development Indicators 2007, World Bank

Figure 12 Forecasts on Global Water Demand (By Usage)



Source: Based on World Water Resources at the Beginning of the 21st Century, UNESCO

Figure 13 Forecasts on Global Water Demand (By Region)



Source: Based on World Water Resources at the Beginning of the 21st Century, UNESCO

While the water demand is increasing, there are some regions where people are now suffering from problems such as decline in groundwater levels and depletion of groundwater due to excessive extraction. Moreover, due to an increase in the demand for agricultural water, industrial water, and water for use in cities, the "stream cease" phenomenon is often observed in China's Yellow River and the Colorado River in the US, and this phenomenon is exerting a significant influence on ecosystems such as aquatic plants and animals including fish.

It is estimated that 1,900 tons of agricultural water is necessary to produce one ton of cereal, thus in countries suffering a shortage of agricultural water, food cereals cannot be produced in amounts necessary to meet domestic demand and they are forced to import to compensate for the shortage. In such a case, it could be considered that the country is securing water resources through food cereal import. This is one of the important factors that needs to be taken into account when considering how to secure enough water resources in the future.

Water quality

It is important not only to consider the quantity of water resources, but also the quality. In the past in many countries, water resources were polluted by agricultural pesticides as well as by unprocessed wastewater from factories and households, causing damage to people's health. In some developing countries that achieved rapid economic growth, there were regions where the number of people suffering from cancer was significantly high, and its cause was thought to be water pollution.(12)

Various chemicals are involved in the production processes and in products, and these can spread into the public water supply through wastewater expelled from factories, waste products, and runoff from farmland that has been sprayed with agricultural pesticides. Moreover, if people eat fish caught in contaminated waters, some chemicals contained in the fish can accumulate in the human body, exposing people to the risk of long-term health damage.

International initiatives for a sustainable use of water resources

The World Water Forum, which is organized by the World Water Council, represents one of the major international initiatives taken by the international community on water issues. The World Water Council (WWC) was established in 1996 by governments, international organizations, experts, companies, and NGOs as an international think tank for water issues and is based in France. At the initiative of the WWC, the World Water Forum was set up as a place where various people who are involved in water issues and policies can gather and discuss the issues in their respective capacities. The first World Water Forum was held in Marrakech in Morocco in 1997. At the second World Water Forum held in the Hague in the Netherlands in 2000, participants proposed "The World Water Vision for the 21st Century" with a view to increasing people's awareness of risks related to water across the globe.

This vision lists the following issues as important challenges to be met regarding water; controlling expansion of irrigated agriculture, raising water productivity, increasing water storage, reformation of water resource management methods, strengthening international cooperation in catchment basin areas, evaluating the functions of ecosystems, and supporting technological innovation.

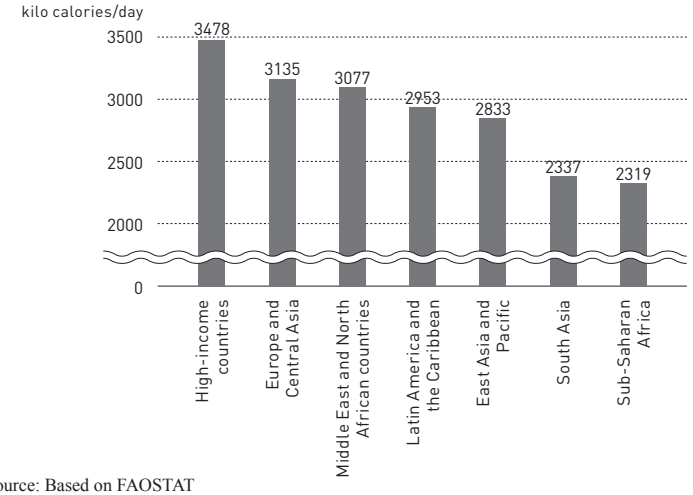
(4) Sustainability and Fairness in Securing Food

Uneven production of food and the need for a fair food distribution

According to the United Nations Food and Agriculture Organization (FAO), about 915 million people were in a state of chronic malnutrition in 2008 and a total of 18 million people are said to have died annually due to diseases brought on by starvation.[13] The calorie supply per-capita (Fig. 14) is the lowest in sub-Saharan Africa, followed by South Asia. The calorie supply in these regions is only about two-thirds of high income states, which demonstrates that there are substantial regional gaps in terms of food supply.

The FAO estimates that the world's total cereal production came to about 2.24 billion tons in 2005. Kawashima (2008)[14] also calculates that if this volume of cereals were equally distributed among the 6.5 billion people in the world, each person would receive about 350 kilograms of cereals annually. If these cereals were supposed to be all rice, the calorie supply per-capita would amount to 2,390 kilocalories per day. Although this is less than the present calorie supply per-capita in Japan of 2,750 kilocalories, in reality, as people eat other foodstuffs in addition to cereals, the present world's cereal production, which could supply every person on the globe with an average of 350 kilograms, would thus seem to be enough to feed all people in the world. There would be no food shortage if the world's food production were distributed fairly across the world. In fact, however, there are regions of the world where people are suffering malnutrition because food is not produced or secured evenly due to regional socioeconomic and natural conditions. Factors that cause these disparities include decreases in agricultural productivity due to natural disasters and regional conflicts, increases in population that exceed the pace of improvement in agricultural productivity, and poverty.

Figure 14 Calorie Supply Per-Capita



Source: Based on FAOSTAT

According to the FAO, the proportion of the world's population suffering from malnutrition was decreasing after the 1970s. However it began to increase again from the middle of the 1990s and reached about 915 million in 2008. In 1996, the World Food Summit was held in Rome, and there a target was set to halve the number of people suffering from malnutrition by 2015. Nonetheless, the population continued to increase, and at the World Food Summit held in 2002, the prospect of achieving the set target of 1996 was seen to be difficult. On top of this, due to increases in population and changes in eating habits (e.g., in the developing countries, the demand for meat is increasing), the demand on cereals as livestock feed is expected to double from the present level by 2020. To meet this increase in demand, cereal production

must also be substantially increased, and it is obvious that new farmland must be developed even in areas with low-quality soil and insufficient rainfall and in outlying regions.

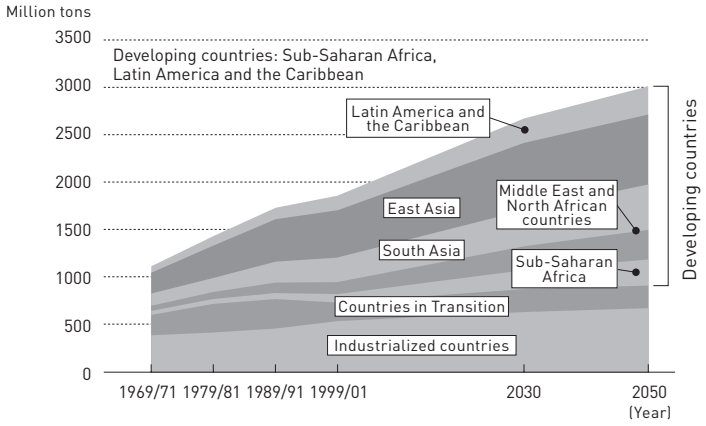
At the same time, in emerging economies such as China, Brazil, and India, two extreme situations are observed: while the poorest people are suffering from malnutrition, the rich are confronted with health problems such as obesity. Moreover, the volume of waste nutrients is rising across the globe: in the world food markets, some foodstuffs are discarded to maintain price levels, and surplus food is sold as livestock feed.

Future food supply and demand

On the future food supply and demand, the FAO's view on cereals describes an increase in developing countries, in particular in East Asia and South Asia (Fig. 15). The cereals self-sufficiency rate per country is also predicted to rise in industrialized countries and countries in transition,[15] and will increase to 120 percent or higher by 2030 (Fig. 16). On the other hand, the cereals self-sufficiency rate in the developing countries will generally decrease, and in the Middle East and North Africa in particular the rate will fall below 60 percent by 2030.

As for the future balance between food supply and demand, world food production will increase due to increases in the yield per area and the development of new farmlands, and eventually could result in sufficient food supply to meet the demand of the world as a whole. Kawashima (2008) estimates that in order to meet world food demand in 2050, the yield per hectare, which was 3.3 tons in 2005, needs to be increased to 4.0 tons by 2050.

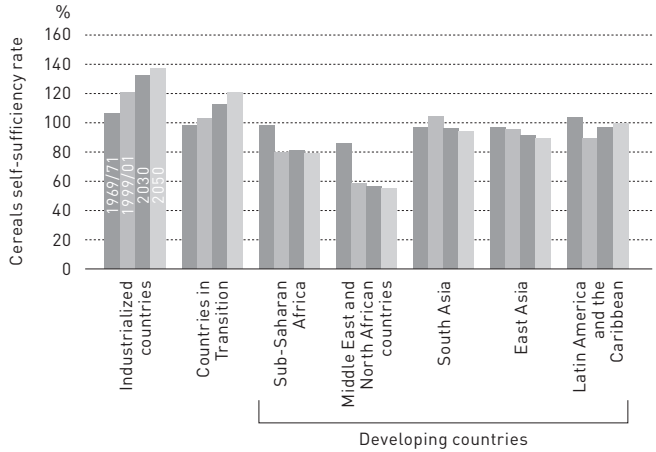
Figure 15 Prospects for Cereal Demand by Region



Note: Countries in Transition refer to East European countries and former Soviet Union countries that are shifting to a market economy.

Source: Based on World Agriculture: Towards 2030/2050 - Interim Report, FAO

Figure 16 Prospects on Cereals Self-Sufficiency Rate by Region



Note: Countries in Transition refer to East European countries and former Soviet Union countries that are shifting to a market economy.

Source: Based on World Agriculture: Towards 2030/2050 - Interim Report, FAO

Mr. Kawashima also believes that it is possible to increase the world average yield by expanding the use of high-yield species, chemical fertilizers and by increased irrigation, and explains that promulgation of these measures will be important and highly effective in regions that currently can only achieve low yields per area.

According to the FAO, there is still enough room to develop farmland in an environmentally conscious manner. For example, it is estimated that in sub-Saharan Africa, at least 700 million hectares of new farmland can be developed.(16) With the approach described above, it is possible to increase the food supply to meet the future food demand, but in reality, the excessive use of chemical fertilizers and agricultural pesticides will degrade the quality of the soil, and climate change will also badly affect food production.

Impact of climate change on food production

Climate change is predicted to have a great impact on world food production and as a result the world food supply situation will become very tight. Some have estimated that in the developing countries, the total agricultural production capacity will decrease by between nine and 21 percent due to global warming.(17)

Africa in particular is vulnerable to climate change, and agricultural production in the region will decrease by between 15 and 30 percent due to global warming. As a result, the region will depend more on imports.(18)

In middle- and high-latitude regions, productivity might improve for some cereals if the world average temperature rise is around 1 to 2 degrees, but if the average temperature rises further, agricultural productivity is predicted to be lowered as a whole.(19)

Impact of food production on the environment

Agriculture is an industry that basically cannot be separated from land, and to obtain farmland the natural environment and the ecosystems will have to be changed, meaning that this is one of the human activities that places a heavy burden on nature.

From the viewpoint of environmental protection, agriculture poses the following problems: destruction of ecosystems due to excessive land development; contamination of soil and pollution of local river water by agricultural pesticides; movement of invisible water resources as a result of importing and exporting agricultural products; impact on other crops with the introduction of genetically modified crops; the diffusion of genes due to unintended genetic recombination.

Securing water and farmland for food production

Irrigation is very effective in producing food efficiently, but only around 17 percent of the world's total farmland is irrigated. Irrigated farmland is responsible for producing one-third or more of the world's food. In the developing countries, about 40 percent of the available water resources are used for irrigation, but at least half of the amount is lost due to leakage and other losses in irrigation channels.(20) In order to improve agricultural productivity in these countries, it is therefore essential to encourage the effective use of irrigation water.

Central and South America and Southeast Asia, farmland can be developed by felling rainforests to increase the yield on a short-term basis, but there are concerns that by losing the tropical rainforests, soil runoff will increase and nutrients in the soil will be affected, which may eventually result in long-term soil deterioration. Moreover, felling too many forests to create farmland will badly affect local biodiversity, as discussed later.

International initiatives for a sustainable food supply

Global efforts in dealing with issues regarding food have been implemented with the focus on measures that include providing support to developing countries facing the problem of unstable food supplies, stabilizing the agricultural market and trade, and promoting world food production.

To support developing countries facing unstable supplies of food, participants in the World Food Summit held in Rome in 1996 issued the Rome Declaration on World Food Security and the World Food Summit Plan of Action, aiming to halve the number of people suffering from malnutrition in the world by 2015, which totaled about 800 million people at that time. Nonetheless, the numbers continued to rise even after the end of the 1996 Summit, and at the World Food Summit held subsequently in 2002, participants admitted that it would be difficult to attain the target set at the 1996 Summit and confirmed the necessity of enhancing international cooperation to eliminate starvation. Later at a high-level meeting held in June 2008, another declaration was issued after reconfirming support on the Rome Declaration and its Plan of Action as well as the Millennium Development Goals(21) (MDGs). Specifically, it declared that not only immediate and short-term measures, but also medium- to long-term measures that would include providing support to measures against climate change for the present food system and encouraging the production and use of bio-fuels while ensuring food security should be taken. Moreover, the G8 Hokkaido Toyako Summit held in July 2008 resulted in the G8 Hokkaido Toyako Summit Leader Declaration, in which the leaders promised to implement medium- to long-term measures, including helping African countries to double their production of major foodstuffs in the next five to 10 years.(22)

3 Crisis Creeping in

The crises outlined in the preceding sections are those having direct impact on human activities, such as the shortage of resources and energy. In this section, we would like to address global warming and the loss of biodiversity, which are issues having great impact on mankind resulting from an upset in the balance of the global environment due to the burden imposed by human activities. These two are crises difficult to recognize because they do not affect our lives in a very obvious manner, and as such could be referred to as "crisis creeping in."

Global warming is believed to be caused by emissions of CO_2 and other greenhouse gases, which increased as a result of our overreliance on fossil fuels as the source of energy for economic development. It is feared that global warming will consequently cause global climate change and have a serious impact on mankind. And with the loss of biodiversity which is caused by a large scale change in nature with mankind expanding the use of land in various ways, it has now become a problem that mankind may lose the foundation of the blessings that they received from the natural world.

(1) Global Warming

The global warming problem

As a result of a range of research efforts, scientists have made steady progress in clarifying the causes of global warming. As a first step in dealing with the issue of global warming, the following

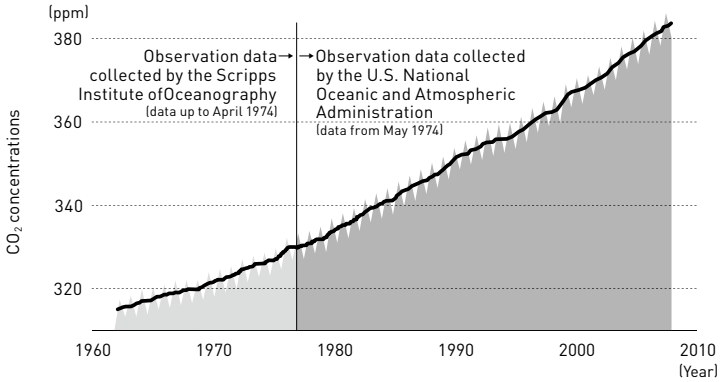
describes what global warming is.

The solar rays reaching the Earth permeate the atmosphere, to be absorbed by the ground surface, eventually warming the Earth's surface. Once the surface is heated, heat is radiated from the heated ground surface into space as infrared rays. In these processes, the atmosphere is heated by both the solar rays and the infrared rays that pass through it. The atmosphere contains gases known as "greenhouse gas" that include CO_2 and methane, which absorbs a part of the heat that the Earth radiates back into space. Then a part of the heat absorbed by greenhouse gases is reemitted back to the Earth, warming the lower layers of the atmosphere and the ground. This mechanism keeps the temperature of the Earth's atmosphere at a level suitable for various living beings on the planet. Nevertheless, as the concentrations of atmospheric greenhouse gases increase, the amount of heat emitted back to the Earth's surface also increases, and this causes a rise in the temperature of the atmosphere and the oceans, and thus the average temperature of the Earth rises. This is the basic mechanism of global warming.

Increase in CO_2 emissions from human activities

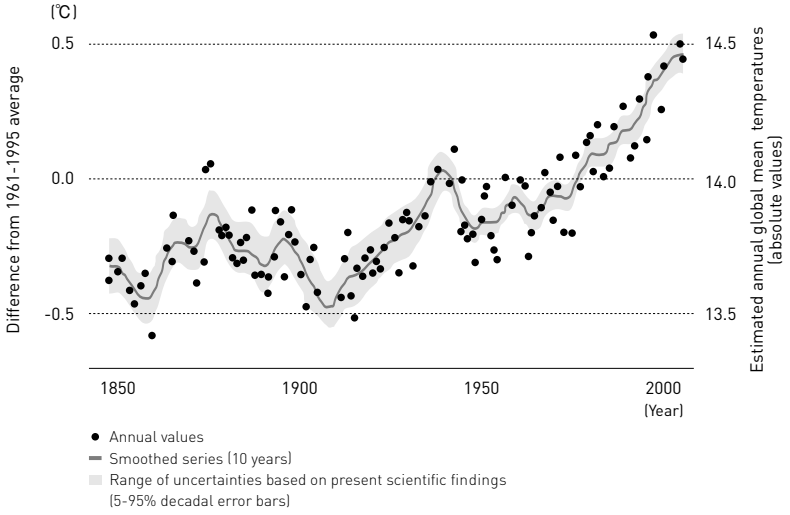
The fact that the atmospheric concentration of CO_2, which is a greenhouse gas, is increasing has been identified by various observations. In particular, the in-depth measurement of atmospheric CO_2 by Charles D. Keeling,[23] a meteorologist, and others is well known (Fig. 17). The measurement began at the U.S. National Oceanic and Atmospheric Administration's Earth System Research Laboratory located in Mauna Loa in Hawaii, following the International Geophysical Year of 1957. The result, known as the "Keeling Curve," shows the level of CO_2 in the atmosphere increasing year by year while making cyclical seasonal changes

Figure 17 Trends in Atmospheric CO_2



Source: Based on the website of the U.S. National Oceanic and Atmospheric Administration: (http://www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mio.html)

Figure 18 Trends in Annual Global Mean Temperatures



Source: Based on data available at the website of Japan Center for Climate Change Actions: http://www.jccca.org/content/view/1730/900/
(Original data: IPCC Fourth Assessment Report)

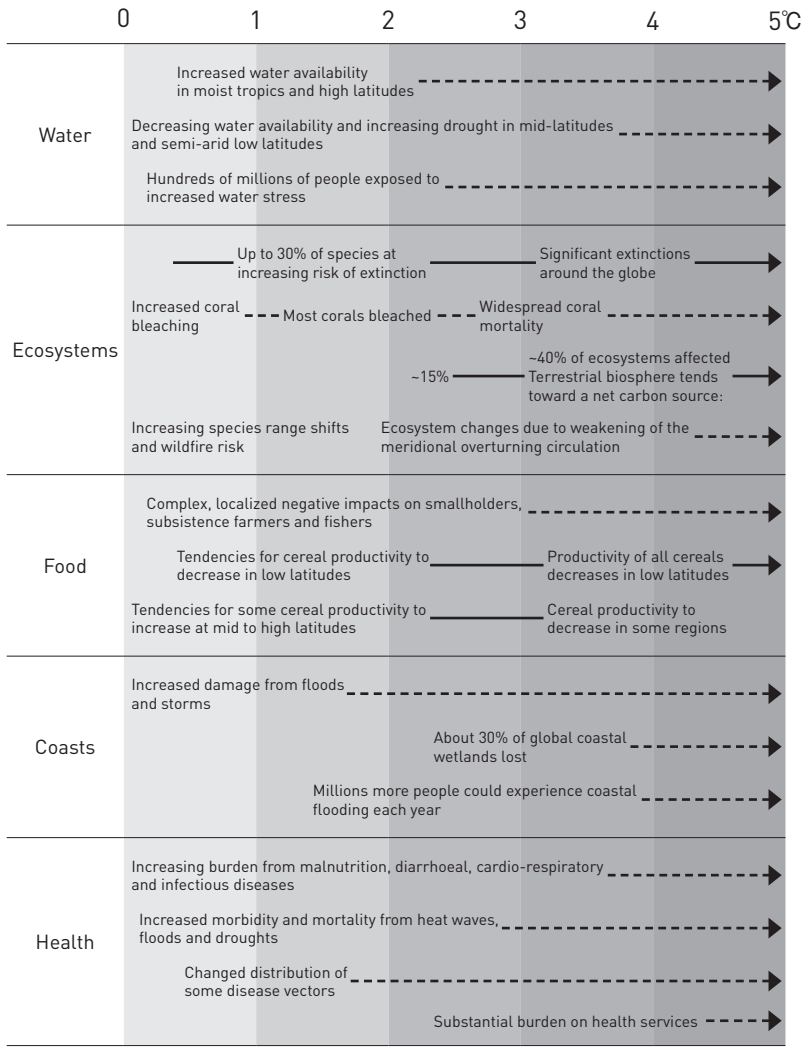
which reflect the growth of plants. Dr. Keeling made great efforts in continuing his observations at the Laboratory and collected CO_2 data over many years, which provided very important information in initiating scientific discussions on global warming.

The IPCC Fourth Assessment Report announced in 2007 by the United Nations Intergovernmental Panel on Climate Change (IPCC) concluded that the increase in greenhouse gases is "very likely" to be attributable to human activities, going a step further than the IPCC Third Assessment Report published in 2001 which assessed human involvement as "likely." According to the Earth System Research Laboratory in Mauna Loa, atmospheric concentrations of CO_2 have increased by about 20 percent or more over the past 50 years (Fig. 18). Also according to the IPCC Fourth Assessment Report, the mean (average) global temperature has risen by about 0.7 degrees centigrade over the past century, and in particular, in the recent 50 years it has risen at a pace that is almost double that over the past 100 years.

Predicted impacts of global warming

In the IPCC Fourth Assessment Report, it is predicted that if the temperature rises by 2 degrees or more compared to the baseline period (1980 to 1999), the scale of damage will increase in various areas (Fig. 19), such as another several 100 million people facing serious shortages of water, up to 30 percent of species in ecosystems facing higher risk of extinction, productivity of cereals decreasing in low-latitude areas, damage from floods and storms increasing in coastal areas and more people suffering from infectious diseases. Global warming will thus have significant impacts across a range of fields. It is also predicted that sea levels will further rise, and in fact countries like Tuvalu and the Maldives

Figure 19 Examples of Impacts Associated with Changes in the Global Average Temperature



Source: Climate Change 2007 Synthesis Report, IPCC

are already facing the risk of being submerged by rises in sea levels showing that the effects of global warming are for real.

Toward a reduction in greenhouse gas emissions

At the Earth Summit held in Rio de Janeiro in 1992, the United Nations Framework Convention on Climate Change was adopted to reduce greenhouse gas emissions, and this came into force in March 1994. The convention aims to achieve the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" and mandates the parties to implement policies to reduce their greenhouse gas emissions under the principles of assuming "common but differentiated responsibilities," "giving consideration to the specific needs and special circumstances of developing country parties", and taking "precautionary measures in a prompt and effective manner".

To prevent global warming then, what should the greenhouse gas emission target be? According to the IPCC Fourth Assessment Report, in order to stabilize the level of atmospheric greenhouse gas at 450ppm, it is essential to reduce global emissions in the next 10 to 15 years to at least half the level of the year 2000. In particular, the Annex I Countries(24) are required to curtail their greenhouse gas emissions by 25 to 40 percent over 1990 levels by 2020 and by 80 to 95 percent by 2050.

The Third Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3) held in Kyoto in 1997 adopted the Kyoto Protocol, which set numerical reduction targets to be achieved by the industrialized countries and the European community. The Kyoto Protocol, which came into force in May 2005, mandates countries to reduce their greenhouse gas emissions by a specified amount over 1990 levels during the first commitment period (2008 to 2012).(25)

At present, studies are being made of numerical targets for the period after the first commitment period (post-Kyoto Protocol period). The Council of the European Union has already reached basic agreement on a policy to reduce their greenhouse gas emissions by at least 20 percent (or by 30 percent depending upon relevant international agreements) from 1990 levels by 2020 (see page 90). As for Japan, at the United Nations Climate Change Summit held in September 2009, then Prime Minister Hatoyama made an international commitment to make it Japan's medium-term target to reduce the country's greenhouse gas emissions by 25 percent over 1990 levels. The United States, which had not been very willing to set reduction targets, changed its attitude following the inauguration of the Obama administration and is now indicating that the United States will lead the world in anti-climate change measures. In the post-Kyoto Protocol measures, it is becoming essential for developing countries to set their reduction targets. Although both China and India are against setting mandatory targets, President Hu Jintao of China announced at the United Nations Climate Change Summit that the country would make an effort to substantially reduce its greenhouse gas emissions per unit gross domestic product (GDP) by 2020 compared to 2005.

In December 2009, the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP15) and the fifth session of the Conference of the Parties to the Kyoto Protocol (COPMOP5) were held in Copenhagen in Denmark, and participants agreed to "take note of" the Copenhagen Accord. Although COP15 was held with the intent to reach political agreement on the Copenhagen Accord, it ended only

with a decision to "take note of" the Accord. This international agreement demands that the parties substantially reduce global greenhouse gas emissions to keep the increase in global temperature to below 2 degrees. Specifically, the accord requires the developed countries to set quantitative reduction targets for 2020 and make commitments to achieving those targets and to give financial support to developing countries which are also required to take action to reduce their greenhouse gas emissions. The accord is thus more in-depth than past summit documents. Although political consensus was not reached on the accord, it must be acknowledged that the countries have acknowledged the importance of the accord, and that will provide the basis for future studies. Nonetheless, with regard to the post-Kyoto Protocol measures, there still lies a large gap in interests between the developed and developing countries and they have yet to examine specific measures to fill the gap toward establishing an effective international framework.

(2) Loss of Biodiversity

Biodiversity and its blessings

Since the birth of life on Earth about four billion years ago, living things have continued to evolve to create the current natural world full of diversity. Specifically, unicellular protozoans evolved into multicellular organisms, from which a variety of land-dwelling creatures were born. Human beings[26] were also born through the process of biological evolution and we cannot completely sever our ties with other creatures.

Biodiversity developed through such biological evolution. Biodiversity refers to diversity (1) in the ecosystems, (2) among biological species, and (3) within the same species (between genes). Diversity in the ecosystems means that different ecosystems exist in different areas according to their different environments. Diversity among biological species means that different species exist in different regions and environments. Diversity within the same species means that even creatures belonging to the same species have different features because of the differences in their genes.

An ecosystem is formed by having its very complex balance maintained. The functions of an ecosystem heavily depend on the diversity of the living beings within it and they relate to and support each other to sustain their lives. An extinction of a species will affect the balance of the ecosystem and lower its value. In our daily lives it is difficult to notice the seriousness of an extinction of a species, but we must understand how severely it could affect nature.

Since ancient times, the lives of human beings heavily depended on nature within its cycles. And, mankind received various blessings from many other living beings and the surrounding environment. Since the beginning of the modern age, however, mankind has been destroying nature through an activity they call "development", which eventually caused global environmental problems.

The health and welfare of mankind depends on ecosystem services brought about by biodiversity. Nature, supported by biodiversity, provides us humans with not only food, materials such as fiber and wood, and ingredients for pharmaceuticals, but also in recent years, information on the genes of various living beings. They have contributed to the development of pharmaceuticals, the production of food and energy, and to the progress of science

(provisioning services). Biodiversity also plays an important role in clarifying air and water, maintaining and promoting the natural environment and the health of mankind (regulating services). And further, biodiversity serves an important role in nurturing local customs, food and other traditional cultures by bringing into play those inherent blessings offered from the mountains, forests, rivers, and sea (cultural services) in the region.

Biodiversity being lost

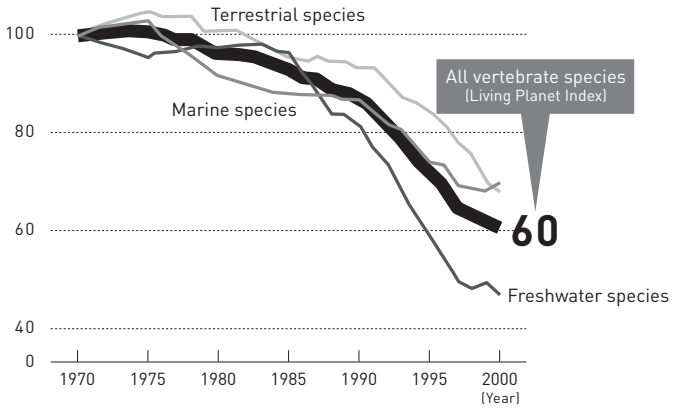
Since life first emerged on Earth, the planet has witnessed a wide spectrum of differentiation in species. The estimated 350,000 species that existed on Earth about 250 million years ago have grown explosively in numbers after they moved their habitat out of the sea onto land, and now it is said that several million species exist on the planet. In the history of the Earth, however, there have been five mass extinctions of species. Many species are said to have become extinct due to collisions by meteorites or tectonics. In spite of such incidences, once the Earth regained an environment that was habitable for the living beings, the number of species grew again to form the present natural environment.

It is said that the living beings on Earth have now entered a period of mass extinction for the sixth time. Researchers including Lord Robert May[27] and Dr. Norman Myers[28] who are past (2001) Blue Planet Prize winners have demonstrated that species on the planet are now facing the danger of mass extinction at an exceedingly fast pace.

Then, how many species are actually decreasing in number? The Living Planet Index (LPI) provides information on changes in the populations of about 3,000 species based on the data made public worldwide. According to the indicator, which was announced by the World Wide Fund for Nature (WWF), the number of species has decreased by about 40 percent during the period from 1970 to 2000. For species living in freshwater, they have decreased by more than 50 percent (Fig. 20).

In fact, how many of Earth's species currently existing are in danger of extinction? Mankind has so far discovered about 1.6 million species. Most vertebrate animals and plants have already been discovered and species yet to be discovered are mostly invertebrate animals. For those already-discovered 1.6 million species, the International Union for Conservation of Nature (IUCN) has been investigating the danger of extinction. The Union has already completed the studies on about 45,000 species, and according to the studies about 40 percent of species are in danger

Figure 20 The Living Planet Index (1970, index=100)



Source: Based on Global Biodiversity Outlook 2 (2008, edited by the Secretariat of the Convention on Biological Diversity and published by the Japanese Ministry of the Environment)
Original data: Living Planet Report (2004) WWF, UNEP-WCMC and Global Footprint Network

of extinction as shown in Table 2.

It is now for the first time in this modern era since the extinction of the dinosaurs 65 million years ago that the abundance and diversity of living beings are decreasing, and on the largest scale ever. For birds, mammals, and amphibians, a total of about 100 species became extinct over the past 100 years, equal to one species per year. This is 50 to 500 times faster than the normal extinction rate recorded in the past. If we take into account those species that became extinct but for which no records were kept, the present extinction rate would be faster than past extinction rates by 1,000 times or more. Furthermore, if we consider insect species whose number is vast, already several tens of thousands of species are thought to have been lost on Earth every year.

Table 2 Percentage of Endangered Species

		Number of species found by humankind	Number of species for which the living status has been investigated (percentage of species for which evaluation work has been completed)		Number of species in danger of extinction	Percentage of species in danger of extinction among those species whose living status was investigated
Vertebrate animals	Mammals	5,488	5,488	(100%)	1,141	21%
	Birds	9,990	9,990	(100%)	1,222	12%
	Reptiles	8,734	1,385	(16%)	423	31%
	Amphibians	6,347	6,260	(99%)	1,905	30%
	Fish	30,700	3,481	(11%)	1,275	37%
Invertebrate animals*		1,232,384	6,161	(0.5%)	2,496	41%
Plants*		298,506	12,055	(4%)	8,457	70%
Others		50,040	18	(0.04%)	9	50%
Total		1,642,189	44,838	(3%)	16,928	38%

* Invertebrate animals (e.g. insects), plants, and other are classified into subgroups in the IUCN Red List, but here only the total numbers are shown.

Source: Based on the IUCN Red List of Threatened Species, ICUN, 2008

Degradation of forests and its impact

Forest ecosystems account for about 10 percent of the Earth's surface area, which is about 30 percent of the land area. The area occupied by these major ecosystems, however, has decreased by 40 percent over the past 300 years and the biodiversity harbored in those forests continues to decline significantly. The largest factor that has contributed to the decrease in biodiversity on land over the past 50 years is thought to be the conversion of forest to farmland (slash-and-burn agriculture and grazing).

In recent years, forests have been increasingly felled amid the shift from a self-sufficient economy to a money economy, the increase in population and the expansion in food (meat) consumption, and the changes in people's values regarding nature (sense of awe). For example, in the Amazon, 70 percent of deforested area has become pastureland. The traditional slash-and-burn method of cultivation done in the past was a sustainable way in utilizing forests when the population density was low, but now it threatens their conservation. Moreover, due to increases in the demand for mineral resources, destruction of forests linked to exploitation of resources is emerging.

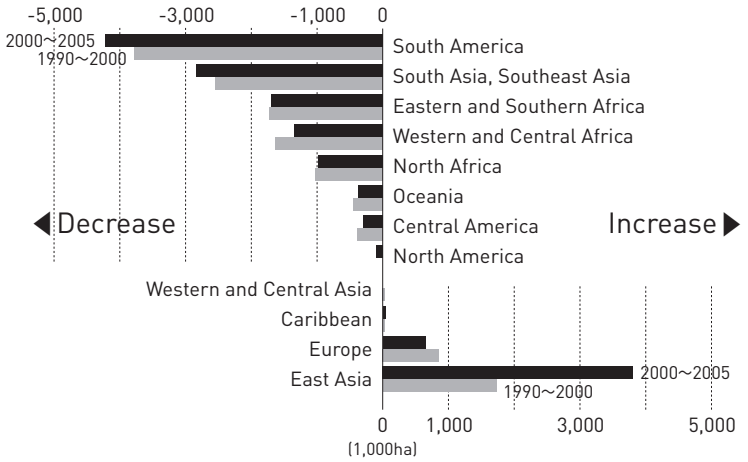
Forest ecosystems provide us with clean and safe water and various other ecosystem services. A decrease in forest area could result in a decrease in precipitation with less water evaporating into the air, which could then cause a shortage of drinking water and health problems, including frequent outbreaks of infectious diseases. It is widely known that forests also play an important role in preventing landslides and slope failures, and with the decrease in forest area, the damage caused by such disasters could spread.

Within other functions that forests serve, circulating oxygen and carbon in the atmosphere and on ground is one that is important.

Until recent times, atmospheric concentrations of CO_2 have been stable owing a lot to plant photosynthesis. In recent years, however, forests have been rapidly developed for use as farmland, and have shrunk because of the increases in areas reclaimed for large-scale slash-and-burn agriculture, inappropriate commercial logging, and forest fires. As a result, about six billion tons of CO_2 have been emitted across the globe,[29] which is equivalent to more than 20 percent of the CO_2 emitted by the use of fossil fuels (26 billion tons per year).

This means that on top of substantially reducing our consumption of fossil fuels to prevent global warming, encouraging forestation and preventing deforestation both have now become very important. According to the IPCC Fourth Assessment Report, it is possible to reduce emissions of CO_2 by 1.3 to 4.2 billion tons annually by increasing forestation and preventing deforestation. At present, however, we cannot say that enough is being done. As shown in figure 21, inappropriate development and logging are still continuing in areas such as South America and Africa, and the world's forest area is continuously on the decline.

Figure 21 Trends in the Area of Forests (1990-2005)



Source: Based on FAO Global Resources Assessment 2005 Progress towards sustainable forest management

Most of the areas where degradation and loss of forests are taking place because of illegal logging and harvesting tend to be economically poor. At the meetings held under the United Nations Framework Convention on Climate Change, discussions are underway to introduce a new system to support the United Nations Program: Reducing Emissions from Deforestation and Degradation in Developing countries (REDD). It is hoped that a system is established so that forests are conserved without illegal logging taking place and to provide benefits to local communities by introducing the idea of price premiums for biodiversity in addition to carbon credits.[30]

Human activities damage the resilience of biodiversity

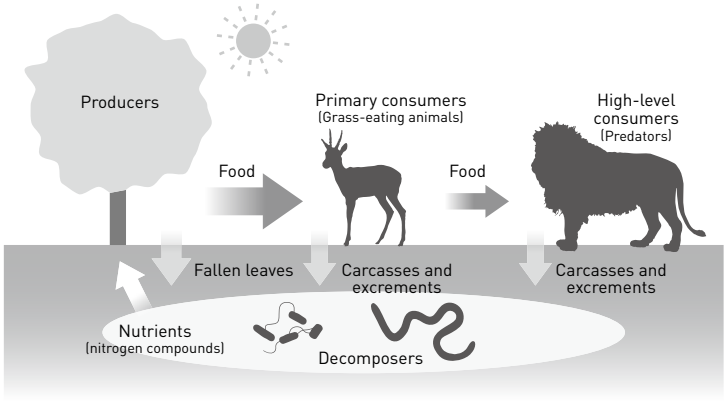
Living beings form ecosystems by building relations with others living in the same area (Fig. 22). An ecosystem is a complex system in which plants, animals, and microorganisms interrelate to each others. In a stable ecosystem, a balance is maintained among the living beings by having a variety of them in it. But with human activities causing devastation to habitats for living things, overexploitation of certain species and populations and pollution of the environment, biodiversity is in a critical situation.

At present, a number of natural ecosystems have lost their balance and have been damaged almost beyond the point of

recovery. The crisis in biodiversity can be seen clearly in the increases in the number of extinct species and those in danger of extinction. These crises originate from human activities, such as deforestation, overexploitation of biological species and populations, overuse of agricultural pesticides, and increases in the number of invasive alien species.

According to the IPCC Fourth Assessment Report the impacts global warming will have on biodiversity are predicted as follows: a decrease in the resilience of ecosystems; a decrease in the amount of carbon absorbed by land-based ecosystems; an increased risk of extinction for biological species; degradation in the goods and services that ecosystems provide (e.g., water and food); and a decrease in the number of biological species such as corals due to acidification of the oceans.

Figure 22 How an Ecosystem Works



Specifically, ecosystems are becoming less resilient with changes in the climate and because of the resulting occurrence of floods, droughts, forest fires, harmful insects, and the acidification of the oceans, and because of the changes in the use of lands, soil contamination, and excessive development of resources. The net amount of carbon absorbed by land-based ecosystems is predicted to reach a peak within the first half of this century and with predictions that the ability to absorb carbon will decrease or even be reversed to emit, it is suggested that climate change may be amplified. If the global average temperature rises by more than 1.5 to 2 degrees, the risk of extinction for about 20 to 30 percent of biological species could become even higher, causing serious negative effect on those goods and services provided by the ecosystem, such as water and food. The acidification of the oceans, which is caused by the increase in atmospheric CO_2 concentration, is predicted to have an adverse impact on oceanic shell-forming creatures such as corals and on all other species that depend on them.

Predicted impact of loss of biodiversity

According to the interim report "The Economics of Ecosystems & Biodiversity (TEEB)",[31] which was announced by the TEEB project team at the ninth meeting of the Conference of the Parties to the Convention on Biodiversity (COP9) held in 2008, the economic loss caused by this loss of biodiversity will reach an amount equivalent to six percent of the world's GDP by 2050 if no proactive measures are taken to prevent it.

With this loss of biodiversity occurring on a global scale, it will become difficult to procure various goods (agricultural products and others) and services (purification of water and air, control

of climate change and natural disasters, and provision of space for recreational activities) from the ecosystem, which have been readily available to us up to now. Moreover, ecosystems might become more vulnerable to disruptions and dramatic change. For example, if an agricultural product depended on only one breed variety and that variety became extinct due to illness or harmful insects, any society that depended on the product would face a serious crisis. By having a variety of species, biological systems can deal with various external factors.

Furthermore, disruptions to ecosystems and loss of biodiversity will have a serious impact on those people who depend directly on services provided by their surrounding ecosystems. For example, there are many people living in a nature-rich regions in developing countries getting water, food, and fuel necessary for their lives from their surrounding natural habitat, such as forests. If the local ecosystems are destroyed, it would become difficult for them to get safe water, food, and fuel from the forest, and because they are living in an area where economic activities tend not to be well developed, they will not be able to get access to water, food, and fuel through the market. Loss of biodiversity will therefore make it more difficult for poor people to break out of poverty. The international community set the Millennium Development Goals (MDGs)[32] as common targets to be pursued to eliminate poverty, and to attain these goals, it is important for communities to conserve biodiversity.

Trends in international initiatives to conserve biodiversity

International initiatives to conserve biodiversity include the Convention on Biological Diversity, the Washington Convention, and the Ramsar Convention. The Washington Convention regulates international trade in endangered wild animals and plants, and the Ramsar Convention is intended to help protect the wetlands that are internationally important habitats for water birds. These two conventions aim to protect biodiversity by focusing on specific species or specific areas, while the Convention on Biological Diversity complements the two conventions and provides a framework for implementing comprehensive measures.

The Convention on Biological Diversity was signed by 168 countries at the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992 and came into force in December 1993. This convention has the following three goals: to conserve a range of living beings and their habitats on Earth; to use biological resources in a sustainable manner; and to share the benefits arising from genetic resources in a fair and equitable manner.

At the sixth meeting of the Conference of the Parties to the Convention on Biological Diversity, the Strategic Plan for the Convention on Biological Diversity was adopted. Based on this plan, the parties are building their capacity for biodiversity conservation, formulating and implementing national strategies, and promoting awareness raising and education on the importance of biodiversity in their respective countries. Their common target is "to achieve by 2010 a substantial reduction in the current rate of biodiversity loss". Nonetheless, according to the progress report on the Strategic Plan at the ninth meeting of the Conference, this common target seemed difficult to achieve, and now the plan is being reviewed to strengthen future efforts. At the 10th meeting of the Conference to be held in Nagoya City, Japan in October 2010, participants will set new targets for biodiversity conservation.

At the meetings of the Conference, discussions were held on

access to genetic resources and allocation of the benefits from these resources. For example, at the sixth meeting, guidelines were adopted for the procurement and use of genetic resources and the fair and equitable sharing of benefits arising from those resources. At present, studies are underway to establish a more detailed and legally binding international framework based on the Convention on Biological Diversity under the auspices of the World Intellectual Property Organization (WIPO). A number of developing countries are now insisting on the need to create a system that allows them to share the profits made from products manufactured using biological resources originating in their countries, while the developed countries take the view that what the developing countries are insisting on could violate the rules of the existing systems for patents and trade-related intellectual property rights (TRIPs). Before establishing an international framework, it would thus seem essential to hold deeper and more detailed discussions.

The Convention on Biological Diversity defines a need for a protocol that sets out the procedures to be followed to prevent living modified organisms (LMOs) (which are organisms modified by modern biotechnology such as genetic manipulation) from badly affecting the conservation(32) and sustainable use of biodiversity. To meet this need, the Cartagena Protocol was adopted in Montreal in June 2000, taking the name of the place where the meeting to formulate the protocol was held. The protocol sets out rules on the import and export of LMOs, and at present, discussions are underway on the international rules that will apply to cases where damage is resulting from the import/export of LMOs.

In addition to conventions intended to conserve biodiversity, there are also various other international initiatives relevant to research in biodiversity, including an international program on biodiversity science called DIVERSITAS, the Global Biodiversity Information Facility (GBIF), and the Global Earth Observation System of Systems (GEOSS). In addition, discussions are underway on establishing an Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) as a platform to coordinate science and policy, which would work for biodiversity in a similar way that IPCC does for climate change.

Chapter 2

A Vision for the 21st Century

—A Solar Energy-Based Society

Dr. James Lovelock,[33] the British scientist who won the Blue Planet Prize in 1997, proposed the Gaia hypothesis which states that there is an interrelation between the biosphere on Earth and the oceans, geosphere, and the atmosphere, and they work to maintain a balance as a whole. This hypothesis regards the Earth as a system behaving like one large living organism. This Earth system can be considered to provide an environment suitable for the survival of mankind. The Earth system is maintained by a good balance between the inorganic non-biological environment that includes sunlight, water and soil, and the biological environment. So, if human activities cause damage to the global environment, which will disturb the balance, this will eventually damage the foundation for the survival of mankind.

How should mankind deal with the crisis that is threatening the very foundation for its survival? As described in Chapter 1, mankind has already begun implementing concrete measures against individual problems. In this chapter, instead of discussing short-term measures to deal with the crisis, we would like to propose a vision to deal with the present crisis more radically and structurally by imagining a century from now and laying out a picture of a society we should aspire to after we overcome the crisis.

1 What Is a "Solar Energy-Based Society?"

Ignorance and indifference toward nature by mankind has brought this crisis that may cause it to lose the foundation for its survival. Why has this happened? It is now necessary to firmly review the relationship between human beings and nature and establish a principle upon which to rebuild the relationship.

(1) As a biological being and a social being

Between biological and social beings

We humans are both social and biological beings. As biological beings, our life depends on nature and we exist within nature as a very tiny part of all living beings. As an entity within nature, man can only be influenced by changes in the natural environment. It is the activities originating from our social being that are causing the environmental problems. Human beings have forgotten that they are an entity within nature, and as social beings have upset the balance of nature that forms the foundation of their existence. Economic development, which has been human-centered lacked a balanced view of nature and that could be said to have brought about the current global environmental problems. Modernization and industrialization since the 18th century have been driven by humans developing, consuming, and disposing of natural resources with the aid of science and technology. Consequently nature is being pushed beyond its ability to recover and the natural resources are being depleted.

To solve our global environmental problems, we need to make better use of science and technology and review our social systems, but first we have to reconsider the human-centered approach and explicitly recognize that we are one of many species, a biological being that depends on nature, and unless a sound natural environment is maintained, the foundation of our very existence will be lost.

As various cells each function within a biological body to sustain the body in the natural world, and as various biological species mutually support each other to form an ecosystem, we must also rethink and confirm once again the mutual relationship among us human beings and understand that no human being lives alone, and that we have survived by each serving a role within a family, or local society or other organizations, and by mutually cooperating within them.

Human beings in nature

As we have hitherto been lacking the viewpoint that we are both biological and social beings and that nature is the foundation for the survival of all living beings, we have pursued our economic activities without recognizing the finiteness of the natural environment and the resources, and the limits to nature's resilience. Our economic activities should serve just as a means to live, but we have been pursuing economic growth only in terms of material wealth and to make our lives more comfortable, without realizing the importance of nature's blessings that support our lives, our mutual reliance on others, and the wealth of the spirit.

It is now time for us to start to understand the complex self-recovering function the Earth possesses to achieve development without weakening nature's resilience or depleting the Earth's natural resources and to set a target for a sustainable coexistence

with nature in a global scale. What is important is to build a society where human beings can lead vibrant lives while maintaining the balance of the natural system.

In order for such a society to be created, it is necessary to maintain the natural system as that is the foundation for the survival of mankind. Here we call this Earth with such a vision "The Blue Planet." Mankind has its existence in nature which includes cosmic space, the Earth, and our own localities, and we depend on it. Therefore, a human society cannot be one that disturbs the balance of nature and instead has to be one that regards the natural environment as the foundation of life and respects its blessings. Thereby, based on the concept that human beings are part of nature, we can dream of a new society that guarantees full cultural diversity for all individuals and societies, and that will transform the Earth into "The Blue Planet."

(2) A Vibrant Solar Energy-Based Society

The 20th century was an era where individuals trying to satisfy themselves went on expanding their own desires and interests and competed. Having focused too much on pursuing individual competition, we have neglected to care for the global environment, nature in its vast and complex entirety. This negligence caused the global environment huge damage and is now threatening the conditions for survival of all living beings including, humans.

This miraculous planet with its abundant life forms that we call Earth would not have come into existence without the Sun, and all forms of life on the planet including ourselves are supported by solar energy. The sun's energy is immense and nature's blessings are created both directly and indirectly by this energy.

Solar heat raises the temperatures of the land and sea surfaces, generating convection currents, and then water vapor in the air transforms itself into raindrops and falls as rain to moisten the land. It is thanks to this heat and water that a vast array of life forms have been born and green plants grow, supporting the lives of plant-eating creatures and nurturing nature on Earth. Furthermore, plants absorb CO_2, and produce oxygen and organic matter through photosynthesis. The Sun shines throughout the Earth providing its blessings without discrimination; all life receives its bounty to support their lives.

Solar energy supporting the lives of all living things including mankind provides its benefits to all. The amount of available solar energy differs by region, which leads to diverse local climates and natural environments. Human beings have adapted to live in nature gradually modifying the way that they live to suit the local environment, and have thus established a multitude of lifestyles and cultures.

For 21st century man to be a society under the Sun full of energy and life for both nature and human beings, we need to put solar energy, which is the basis for all life, in the center and by placing the utmost value on nature itself, respect the diverse and mutual values between all living things and humans, let their vital power flourish under the Sun. Here we shall call such a society a "solar energy-based society," one which works not solely for the benefit of human beings and not only for the rich or for the powerful countries.

In the following paragraphs, we will lay out a little in detail the concept of a "solar energy-based society." Before the Industrial Revolution started, people lived in and alongside

nature, receiving the blessings of the Sun every day. Since the Industrial Revolution, however, people became dependent on "fossil fuels" to expand their economic activities. Fossil fuels are a form of resource wealth produced through many years of accumulation of the Sun's blessings. But a huge amount of fossil fuel is wasted every year. As a result, we are now facing a crisis: the depletion of fossil fuels and global warming. In addition, due to the regional disparities in the availability of fossil fuels and in the technologies to use these fuels, new problems such as the gaps in the standard of living and economic progress between regions are emerging.

In order to overcome these problems, it is essential to affirm once again the importance of respecting nature and all living beings on Earth; they are all supported by the Sun's blessings. All living beings are supported by resources that are produced by solar energy, and the only way to overcome the present crisis is to build a society in which we can use the solar energy provided each day by the Sun instead of using up the accumulated resources of the Earth.

The "solar energy-based society" which we propose in this document does not simply refer to a society that uses solar energy. It also considers sustainable conservation of the natural environment, including life that is supported by the Sun as the foundation of the society. Specifically, society as we envision should have the following features:

1. A society that values nature itself
2. A cooperative society that extends consideration for nature and for others

(3) Vision of a Solar Energy-Based Society

A society that values nature itself

Most people in the world have been unaware of or indifferent to the existence of the natural world, which is the foundation of life for all creatures on Earth. And in the process of economic development without being conscious of the various blessings nature provides, they made changes to nature and put a burden on it. As a result, global environmental problems, represented by global warming and loss of biodiversity have emerged. Mankind has taken nature's blessings for granted forgetting that humans as biological beings can only exist within the limits of nature and is exploiting resources in a way that is damaging nature beyond its ability to recover. What we are facing now is the natural outcome of what we did in the past.

Since the first life emerged on Earth about four billion years ago, life has been repeating the cycles of birth, extinction, and evolution, and as a result, there are now several million species on Earth. Mankind is just one of these species created through evolution just as others. But since the beginning of the Industrial Revolution, following increases in population and the growth of the market economy, mankind has increased the production of food and materials, and promoted industrialization and urbanization thereby modifying nature and depriving it of biological resources, and polluting the environment. As a result, a huge number of species have become extinct. The extinction rate is accelerating and today we are facing a crisis with loss of biodiversity. Fossil fuels, which were formed by the accumulation of organic material over several hundred million years, have nearly been depleted in only a few hundred years due to excessive exploitation by human beings.

All living things including humans as biological beings live in symbiosis with nature with mutual connections. Mankind endangers its own sustainability by damaging nature beyond its ability to recover. We must look once again at the significance and value of nature, which supports all life on Earth, including our own and reevaluate it. To prevent global environmental problems from becoming worse and to pass down the myriad blessings we receive from the natural world to future generations, we must transform our society to one in which people live in harmony with nature and as an integral part of the natural world.

That is a society where people regard the natural environment as the foundation for their lives and value its blessings, and can be referred to as a "solar energy-based society." Nature is valuable to mankind not just because we can use its resources, but as nature itself which is the very foundation for mankind to survive. To recognize the value of nature itself requires us to base our activities in harmony with nature. And living in harmony with nature will in turn help us create a society in which people value nature itself.

Dr. Amory B. Lovins,[34] who received the Blue Planet Prize in 2007, urges us to shift from industrial capitalism to natural capitalism. Here, the natural capital does not simply mean nature's ecosystems. It also refers to fertile soil, circulation of the atmosphere, and other infrastructures that provide mankind with the environment necessary to maintain its life, and to all the resources used by human beings, such as water, minerals, and oil. Natural capitalism means pursuit of an economic society that takes into account the value of nature's capital by revisiting the dependency relation between the maintenance and supply of natural capital and the industrial production carried out by human beings. Natural capitalism regards nature as the capital needed for the economic society and gives consideration in sustaining it. It therefore recognizes the value of nature and provides the core idea for the creation of a society that values and harmonizes with nature.

Professor Hirofumi Uzawa, who won the Blue Planet Prize in 2009, also advocates the importance of appropriately controlling and managing both the natural environment and social systems in maintaining a society continually and stably, based on his unique concept of "social common capital." Social common capital means a natural environment and social systems that will enable a country or a region to pursue a rich economic life, develop an outstanding culture and maintain sustainably and stably a society humanly attractive. The natural environment is the most important social common capital, since it comprises mountains, forests, rivers, lakes and ponds, and the oceans as well as water, soil, and the air. The concept of social common capital which considers the natural environment as essential has the same sense of values as the "solar energy-based society" where the natural environment is regarded as indispensable for humans and all other living beings to live.

A cooperative society that extends consideration for nature and for others

Our market economy-driven societies of the 20th century attributed importance to the principle of the market mechanism. Competition motivated individuals to become creative and energized the society. At the same time, however, competition intensified without due consideration being given to the fact that human beings are biological beings who belong to nature, and that this competition was contributing to the destruction of the natural environment.

Based on the idea that human beings are part of nature and that people depend on each other in the society, can we not say that

we need to place more value on cooperation than on competition in the 21st century? When we deeply think about the possibility of the survival of mankind, we learn that mankind lives thanks to nature's blessings, that is, without such blessings it cannot live. At the same time, it tells us that in this complex society, many entities live in mutual dependence, and that they cannot live free of interpersonal relations. Based on this recognition, everyone should be able to understand that as individuals they have their respective roles in nature and in the society and it is important to have "consideration" for others. "Consideration for others" means to respect the independence of people in different positions. In a society composed of individuals of different gender, age, and ability, mutual respect is essential to ensure peaceful and fair relationships between people. In particular, regarding the issue of having respect for the socially weak who tend to be neglected in our market economy-driven society, the society must face up to the problems they present.

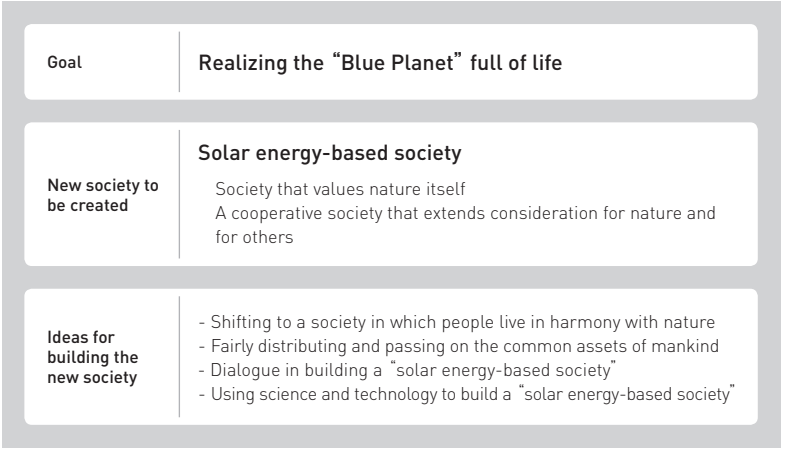
We must have "consideration for others" not only for individuals but also for other countries, future generations, and for nature. Being considerate to others means we are motivated to support each other—something that we can never do in the competitive pursuit of individual interests. People consider and support each other when they respect each other, and such mutual respect will help to build an energetic society full of diversity.

In order to realize a vibrant society oriented towards cooperation, individuals, companies, and countries should respect nature in their respective capacities and continue to search for the new mankind that lives in harmony with nature. Individuals must establish new lifestyles that set the value "consideration for others" in the center. Companies must build new corporate philosophies that take into consideration nature's ability to recover based on the concept of consideration for nature. Countries, on the other hand, must clarify what they should do for global environment and to sustain mankind while globalizing their economic activities and deepening intergovernmental relations. Countries must then take cooperative actions, taking fully into account their impact on other countries and the global environment.

In this way, a society that can cooperate in every field with full consideration given to nature and others will be the foundation for the "solar energy-based society."

Figure 23 shows our vision of a future solar energy-based society.

Figure 23 Vision for a New Society



2 Building a "Solar Energy-Based Society"

(1) Shift to a Society that is in Harmony with Nature

Mankind has expanded its economic activities without considering the limits to nature's ability to recover. The Club of Rome warned the international community about nature's limits in *The Limits to Growth,* but ignorance in trying to understand those limits has continued to the present. Along with the globalization taking place in the market economy, competition has intensified in economic societies, and people and organizations have pursued a self-centered development unscrupulously to survive in the market. Competition adds vigor to the market, but if countries are fatally defeated in competing for markets, the entire society will eventually lose its vigor. We need to re-realize that at the beginning we lived in harmony with nature in an interdependent way, and from now on pursue moderate activities wherein others and other countries can recover by setting action principles where society never presses nature beyond its ability to recover and live in harmony with nature

Since humans appeared on this Earth, mankind has been an entity receiving the blessings of nature. As far as nature itself sustained its balance maintaining its harmony, mankind could receive those blessings without disturbing the harmony of nature if the blessings were used within the range of the natural cycle or resilience. But the problems of shortages of water and food that we have begun to see recently could be considered a result of overuse of nature beyond limits. Predictions suggest that the world's population will continue to increase with the demand for water and food also rising, which will make the problems with water and food a serious concern if appropriate measures are not taken.

To solve these problems, it is indispensable to limit our use of nature to a range that will not hinder the natural cycle and resilience, so that mankind continues to appreciate the abundant blessings nature provides. To this end, we must create a society following the idea mankind has inherited through the years in which we use water, forests, and land in harmony with nature and in line with its natural circulation. We also need to understand the complex relationship between nature and human beings and continue to search for a better coexisting relationship between the two.

(2) Fair Distribution and Passing On of the Common Assets of Mankind

The concept of "sustainable development," which the Brundtland Commission proposed in the report it published in 1987 specifically means "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" and is intended to help achieve fairness down the generations. Nature meets a variety of human needs and provides the foundation for human life, and if nature is badly damaged by development by the current generation, future generations will lose the foundation of their lives and will not be able to meet their own needs. We need therefore to re-recognize that nature provides a foundation also for the lives of future generations and that we have the responsibility to pass on nature's riches, which provide both spiritual and material blessings to future generations.

We must pass on not only a healthy natural environment

but also social infrastructure that includes roads, transportation facilities, water supplies and sewage systems, electricity and gas; social institutions such as educational systems, medical care, legal affairs, culture, and financial services; and also the knowledge accumulated by mankind. The natural environments, social infrastructure, social institutions, and knowledge together comprise an indispensable common asset for society to preserve and maintain the lives, livelihoods and dignity of mankind. It is important to ensure that the social infrastructure, social institutions, and knowledge are used in a way that helps to build a human society that values nature as the foundation for survival.

In pursuing fairness among regions, it is also important to correct the one-sided exploitation and unfair distribution of resources which occurs between developed and developing countries. For example, global warming has the largest effect on developing countries and their people, so in coping with the problem, it is vital that we consider the huge gap between the developed and developing countries in terms of technological development capabilities and cost-sharing abilities.

(3) Dialogue for building a "Solar Energy-Based Society"

When we look at the cause and the effect of the crisis caused by global environmental problems, as they relate to all human activities, all the people in the world are required to participate and cooperate. For that purpose, it is vital to build social ties so that the problem can be dealt with by the world as a whole. Social ties are established between individuals, companies, local communities, NGOs, nations, and other entities and also those in the same category (among individuals, among companies, among local communities, among NGOs, and among nations). As described in the section on "a cooperative society that extends consideration for nature and others," in order to create a tie between different entities, people must first establish relations where they mutually respect and care for each other's positions.

In order to create relations where people mutually care for each other, it is necessary to promote a dialogue to seek a way that will benefit both parties upon recognizing each other's position and the mutual relationship instead of selfishly seeking to win each discussion or negotiation. By building relationships through dialogue, each entity will be able to clarify its own role to ensure that all the parties will receive long-term benefits. In the process of global consensus building to create a society in which people live in harmony with nature, and to make clear the roles of each entity for its implementation, it will be necessary to establish a system that enables various entities to collaborate and cooperate through dialogues.

However, countries sometimes try to protect their own interests at the expense of others. Countries even start wars when confronted. If we rethink the fact that human beings depend on both nature and each other, even between countries, it becomes important to build a better relationship of respecting each other. In order to solve global environmental problems, it is necessary for each country to take action that goes beyond national interests, and a community of nations such as the EU provides a good example of initiatives taken in international cooperation. Wouldn't more countries reach consensus and take international decisions more effectively if they established a community that enables its members to engage in dialogue beyond national interests?

(4) Science and Technology Toward Building a "Solar Energy-Based Society"

How should science and technology be involved in solving the global environmental problems? Global environmental problems such as global warming and loss of biodiversity are huge in scale and involve a range of complex factors, and it will therefore take a long time to elucidate all the factors that cause the problems. However, if no one acts until after all the factors are identified and optimal solutions devised, it is very likely that the problem will be aggravated to a level so bad that the situation becomes out of hand and can no longer be solved. It is therefore necessary to take an anticipatory approach(35) to the problem to prevent the occurrence of irreversible damage. For example, we should assess the risk of development activities before they are implemented based on objective data using all the expertise and technology that are available. In making an assessment, we should estimate the impact of the activity not only on the environment but also on the society and the economy, which will help us examine interdisciplinary measures to solve the problem.

Next, in what direction should science and technology move in the long-term? So far, science and technology have been utilized to bring us material wealth and comfort. But there is another aspect to this. The global environment has been damaged, as science and technology were used without consideration being given to what impact their use would have on the environment and the society. It is true that science and technology also provide us with solutions to global environmental problems. We must therefore develop science and technology as a way to solve global environmental problems by utilizing it as a means to build a society that harmonizes with nature, keeping in mind how the use of science and technology could impact the environment and the society.

To promote science and technology to realize the "Blue Planet," we must evaluate the implications of science and technology from multiple viewpoints, including how they will affect the environment and the society. To this end, it is necessary to use knowledge from the human and social sciences in addition to natural science to cover a range of fields in an integrated manner. By knowledge, we mean knowledge of ethics and social systems that can enable us to live in harmony with nature. We must use both knowledge from science and technology and from the human and social sciences in a comprehensive manner to solve global environmental problems. For that purpose, it will become more important to take an interdisciplinary approach to research that will allow researchers to study a problem in a comprehensive manner, instead of focusing on a strictly subdivided field of research.

Science and technology should be developed and used in a way that contributes to the sustainability of our societies with the intention of building a solar energy-based society. If utilized in this direction, science and technology will provide us with a powerful and essential tool for change in realizing the "Blue Planet."

Solar energy provides the very source of life for all living beings on Earth, and the biosphere is maintained by the energy irradiated constantly onto the Earth's surface. We must outgrow from energy supplies that depend on depleting fossil fuels, and build a society in which we can live in harmony with nature. To achieve this, it is important to make more effective use of solar energy as a sustainable energy source, and for that purpose science and technology must play an important role.

Chapter 3

Future Society Created by Overcoming Crises

The Path to a Vibrant Solar Energy-Based Society

A solar energy-based society is a future society created through overcoming the current crises. What milestones are there on our way to building such a future society? In this chapter, we will consider this, focusing on the following themes: a shift to a society that values nature itself, the sustainable use of energy, changes in lifestyles, cooperation between urban and rural areas, improvements in our social systems, and international cooperation.

1 Building a Society that Values Nature Itself

Nature and its ecosystems have the ability to recover by themselves, but the crisis in biodiversity is caused by human activities that go beyond nature's resilience, meaning that man as a biological being is damaging the foundations of his own existence. Dr. Paul R. Ehrlich[36] made it clear that it is essential for the existence of mankind to maintain a stable ecosystem which supports biodiversity. Dr. Ehrlich contributed to the development of the academic field of "co-evolution," which means that species evolve in the ecosystem by mutually affecting each other. It is important for all people to share and recognize that all living beings, including human beings are living their lives with mutual ties and to make the effort to create a society in which humans coexist with other living things as part of nature.

Mankind would have been able to continue to enjoy nature's blessings if it had lived in harmony with nature limiting its use within the natural cycle and its resilience, but problems such as water and food shortages across the globe which we have faced recently seem to indicate that we have exploited nature beyond its limits. With the world's population projected to continue increasing, it is predicted that demand for water and food will increase, raising concerns that the situation will become more serious unless appropriate countermeasures are taken.

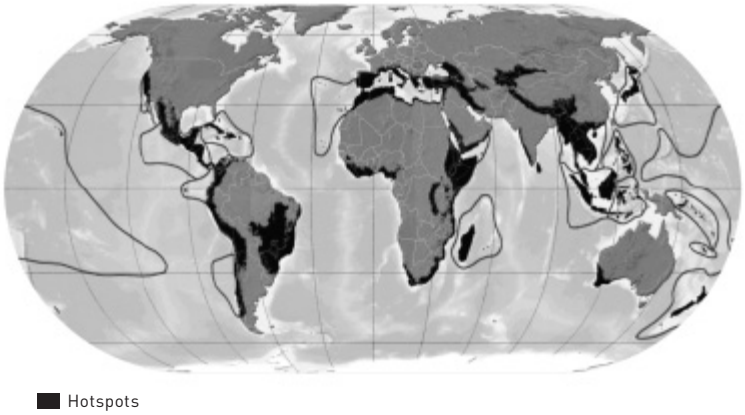
In order to deal with the problem and ensure that mankind can continuously enjoy the great blessings of nature, it is essential that we use nature within a range that does not damage the natural cycle and its resilience. To achieve this, it is necessary to build a society based on the concept of living in harmony with nature, in which people use water, forests, and land in a manner that does not damage the natural cycle.

(1) Conservation of the Natural Environment

To "value nature itself" means to recognize the value that natural ecosystems depend mutually on the subtle balance among living things, water, and land, and thus it can be said to conserve the entire natural environment including water and land as it is, is the best.

The Earth is home to a large variety of living things, but more than a few are in danger of extinction. In response, the areas of global importance for biodiversity are designated as "hotspots."[37] (Fig. 24) By implementing measures to protect biodiversity in these areas, we can preserve large numbers of species.

Figure 24 Biodiversity Hotspots (2004)



Source: Biodiversity Hotspots, Conservation International (2004)

Although the number of areas in which biodiversity conservation is being implemented has been increasing year by year, the criteria for selecting natural sanctuaries and their management methods are not standardized. In developing countries in particular, illegal logging often happens due to inappropriate management in a number of national parks, and it is important to standardize the selection criteria and management methods.

To conserve biodiversity, the international community is now in the process of creating a new funding mechanism. Within developing countries, although they may be rich in biodiversity, there are a number of areas where biodiversity is not fully conserved due to a lack of financial and human resources. As a mechanism to fund activities in such areas, there is the Critical Ecosystem Partnership Fund (CEPF). This fund, for example, gives long-term support to NGOs that are engaged in biodiversity conservation in hotspots located in developing countries, local social organizations, and other civil organizations. The CEPF was established with a joint public fund by the following organizations in 2000: The Global Environment Facility,(38) The World Bank, Conservation International,(39) the Japanese Government, The John D. and Catherine McArthur Foundation, and the French Development Agency. In order to achieve biodiversity conservation, such methods as having funds continuously flow from developed countries—the beneficiaries of biodiversity— to developing countries—the suppliers of biodiversity and resources —are being considered. It is considered effective to conserve the global natural environment by establishing such a funding mechanism (GDM: Green Development Mechanism).(40)

It might also be effective to designate an entire biodiversity hotspot as a sanctuary for biodiversity, but such a designation would affect the lives of people living in the area because local development activities would be restricted. There may be cases where it is difficult to designate the hotspots as sanctuaries. If the entire natural environment cannot be preserved, it is at least necessary to preserve particularly valuable species for their use as gene resources in the future. For such preservation, there are methods where individual plants and animals are preserved in facilities like centers for rare species, aquariums, zoos, and botanical gardens, or methods where some parts of organisms such as seeds and cells are preserved in gene banks. Gene resources are a common asset for the whole of mankind, and in order to pass on this important asset to future generations, we must build a global system in which gene resources can be preserved and managed in a sustainable and systematic manner. The natural resources of the whole Earth cannot be protected if countries act only in their own interests. In formulating an effective international framework to protect the Earth's natural assets 100 years from now, it is indispensable to build a cooperative system that is beyond national interests.

(2) Development that is in Harmony with Nature

In order to realize a society that harmonizes with nature, it is first necessary for us to fully understand the mechanisms of nature, including water circulation, interrelationships between nature and its living beings, and the productivity of land. Based on those understandings and on treating the natural world with respect, we must review our past development methods and change them to be in harmony with nature. Moreover, we must become aware of the importance of learning from nature, and develop science and technology, not to conquer and change nature as we did in the past,

but to transform it and use in ways that will enable us to develop nature in harmony with the natural world.

It will take time to fully understand all the complex mechanisms of nature. However, if we wait to review our past development methods until we fully understand all of nature's mechanisms, it will be too late. While using science to elucidate those mechanisms, we must also search for development methods that do not harm the natural world, taking a precautionary approach that is mindful of uncertain factors, such as the impact that global warming might have on water resources and ecosystems.

(3) Development That Does Not Obstruct the Natural Circulation of Water

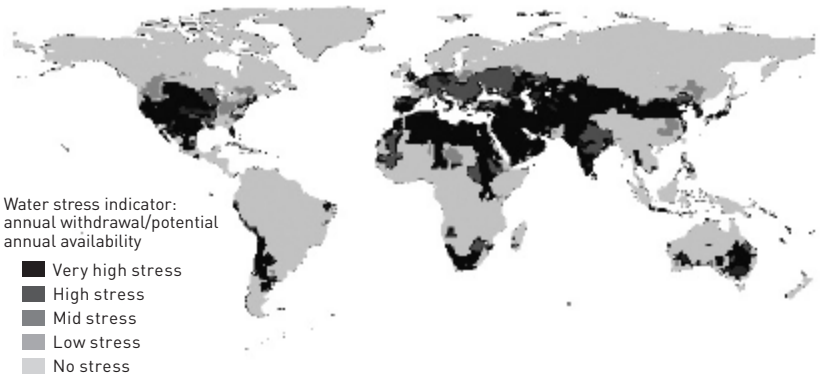
The amount of water circulated on Earth is defined by natural conditions, and in theory by calculating the global total annual demand, there should be no water shortage. However, due to regional differences in the availability of water resources, seasonal differences in precipitation, and changes in precipitation patterns caused by long-term climate changes, it has become a global issue that there are now regions where water cannot be supplied in a stable manner.

Additionally due to climate changes caused by global warming, precipitation patterns and water evaporation could change in many regions, which could cause water shortages in a large number of regions. Figure 25 shows a world map of water, using a water stress indicator (annual withdrawal to availability ratio of water). The water stress indicator reflects not only regional differences in the availability of water resources due to differences in climatic and geographical conditions but also socioeconomic factors such as population and the level of water supply infrastructures. As shown on the map, regions that include the northern part of China, Central Asia, the Middle East, the northern part of Africa, and the western part of the United States are under high water stress.

Water circulates according to natural mechanisms, and from a long-term viewpoint looking forward 100 years from now, it makes sense to use water in a way that is in harmony with the natural circulation of water. Accordingly, we must deal with the problem of water shortages, not by adopting water procurement methods that will require the use of large amounts of energy, or involving long-distance transportation of water or desalination of seawater; rather, we must tackle the problem based on the concept that we must limit our use of water to the amount that is available.

To this end, we must establish a cooperative system beyond regional and national boundaries. Under this system, the amount of water

Figure 25 Global Water Stress



Source: Based on World Water in 2025, Kassel World Water Series Report No. 2

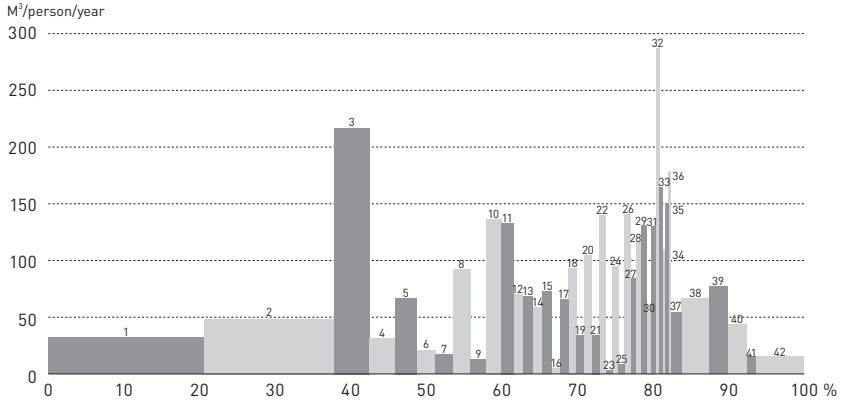
available should be identified for each basin area, and the development of the area and local water use must be managed to ensure that the natural circulation of water is not obstructed. These measures must include controlling the local population and assigning land to industry within the limits set by the availability of water in that locality.

The use of water for agriculture accounts for about 70 percent of the world's water use, and thus represents a major part of water usage. It is therefore vital to ensure that irrigation is carried out efficiently. If irrigation is done inefficiently, water will be wasted by evaporation, which together with leakage in damaged irrigation channels will substantially decrease the efficiency. In particular in developing countries, where surface irrigation is the mainstream irrigation method, a large amount of water evaporates, making the use of water inefficient. Saving irrigation water is therefore a very effective solution to water shortage problems, and the developed countries could provide very effective technical support to the developing countries, specifically by helping them to reduce water evaporation, keep leakages to a minimum and make use of underground water reserves.

In the developing countries, there are large numbers of people who have no access to safe water despite the fact that there are enough water resources around them. For these people, the advanced water technologies that developed countries hold can play an important role. It is important that the developed countries offer technological and financial support to the developing countries to help them improve their water supply infrastructures. One effective way could be for the developed countries to concentrate their support on a model city or an area to clearly demonstrate the actual effect of their support. In giving such support, it is important for the donor countries to ensure that they not only build the necessary infrastructure, but also train engineers so that the developing countries can continue to maintain and manage the infrastructure themselves in a sustainable manner.

As shown in figure 26, the per-capita consumption of municipal water is large particularly in developed countries, such as Australia, the United States, Canada, Italy, and Japan. Excessive use of water in developed countries often leads them to cases where they look to other countries to secure new supplies, which could cause a destruction of the natural environment in the supplier countries. Although it is true that water savings in Japan will not directly improve the supply-demand balance in areas of the world suffering water shortages, it is necessary for the entire international community to understand the water demand situation and the

Figure 26 Per-Capita Consumption of Municipal Water



1. China
2. India
3. The United States
4. Indonesia
5. Brazil
6. Pakistan
7. Bangladesh
8. The Russian Federation
9. Nigeria
10. Japan
11. Mexico
12. Germany
13. Vietnam
14. The Philippines
15. Egypt
16. Ethiopia
17. Iran
18. Turkey
19. Thailand
20. France
21. The United Kingdom
22. Italy
23. The Democratic Republic of Congo
24. Ukraine
25. Myanmar
26. South Korea
27. South Africa
28. Spain
29. Columbia
30. Poland
31. Argentina
32. Canada
33. Iraq
34. Uzbekistan
35. Venezuela
36. Australia
37. Other East Asian and Pacific countries
38. Other European and Central Asian countries
39. Other South American and Caribbean countries
40. Other Middle East and North African countries
41. Other South Asian countries
42. Other sub-Saharan African countries

Source: Based on AWQUASTAT, FAO

preciousness of water resources and become more aware of the importance of making effective use of them.

(4) Protecting Productivity of the Land and the Fair Distribution of Food

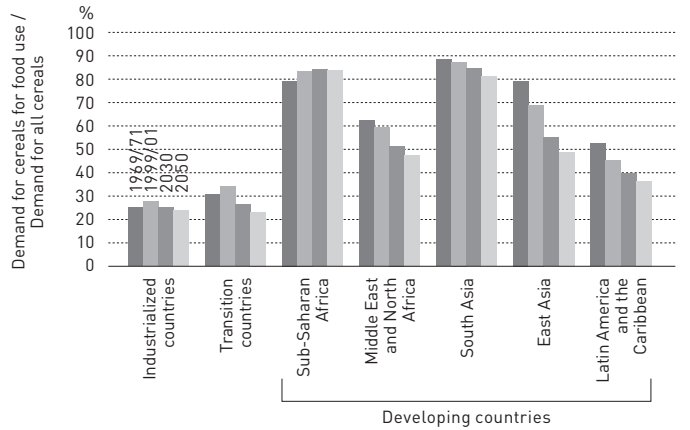
There are two feasible solutions to the food problem: the first solution is to optimize food production and the second is to optimize the distribution of food.

When we look at the world, land productivity differs greatly according to the area and it would be possible to increase food production by making better use of highly productive land across the world, which could potentially solve the problem of food shortages if such an action is taken on a global level. It is also good for the natural environment to make effective use of land suitable for food production, since it will help to prevent the destruction of natural habitat through unnecessary development of land. Food production, however, is related to national security and at present it is not practically possible for countries to come up with a global food production plan according to the productivity of each land area and circulate food across the world. From a very long-term view of looking at 100 years from now, we need to start discussing how to achieve an appropriate production and distribution of food for the world.

At present, while some countries are suffering from famine, there are others that are overeating, where food is wasted in large amounts and people are suffering heath problems due to an excessive intake of calories. It is expected that the global food problem will be mitigated by narrowing the gap between these countries, and for this to be realized, a food distribution framework supported by a strong international cooperation needs to be established.

The production of cereals has been increasing since 1950 due to the following factors: the introduction of more productive varieties; an increase in irrigated areas as a result of the spread in irrigation technologies; and the expanded use of fertilizers. In emerging economies such as China and India, the need for food is becoming increasingly diversified as the standards of living improve, and people are now eating more animal protein, which in turn is increasing the demand for livestock food products. To produce livestock, it requires a large amount of water and cereal feed. For example on a mass basis, eight kilograms of cereals are needed to produce one kilogram of beef, four kilograms for pork, and two and a half kilograms for chicken meat. Figure 27 shows that the ratio of cereal production for food use will decline with the rise in the ratio of cereal production

Figure 27 Prospects for the Percentages of Cereals for Food Use in the Demand for Cereals (by Region)



Note: Transition countries refer to East European countries and former Soviet Union countries that are shifting to a market economy. The demand for cereals other than cereals for food use could include the demand for cereals for use as feed and other cereals.

Source: Based on World Agriculture Towards 2030/2050 - Interim Report, FAO

for feed use. This implies that global livestock food production will further increase due to changes in people's dietary habits. On the other hand, yields of cereals have been decreasing due to the shortage of irrigation water and hikes in fuel prices, and it is not clear whether there will be significant progress in agricultural technologies (for breeding etc.). We cannot therefore expect the production of cereals for use in feeds to increase significantly in the future.

The entire world might face food shortages with the increase in world population. People have their own taste in food and it is up to each individual to choose what to eat, but when we look to the future, people in the developed countries might have to rethink what they eat if we are going to avoid food shortages in the future.

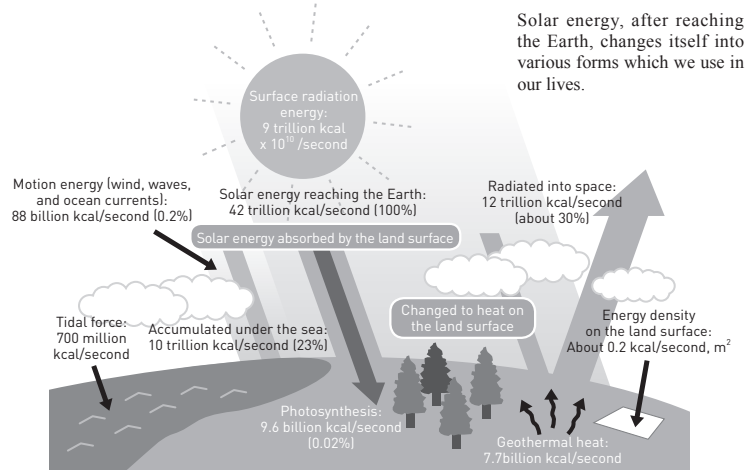
2 Toward a Sustainable Use of Energy

(1) Abundant Solar Energy and Its Uses

Fossil fuels are limited resources, and as indicated by the "peak oil" theory, the world oil production will begin to decrease after reaching a peak and oil reserves will finally be depleted. It is therefore impossible to continue to follow a lifestyle depending on fossil fuels for more than 100 years from now, and we must implement measures to move away from our present fossil fuel-dependent society. Specifically, we must aim to stop depending on fossil fuels and achieve a "sustainable society that is based on the use of solar energy."

Figure 28 shows in what form is the solar energy reaching the

Figure 28 Uses of Solar Energy



Source: Japan Photovoltaic Energy Association

Earth is transformed into and used. As shown, various forms of energy are utilized to support nature and the lives of living beings including mankind.

The amount of solar energy that reaches the Earth in an hour is far larger than the amount of energy consumed by the whole world in a year. After reaching the planet, solar energy is transformed into heat on the land and sea surfaces, and a very small portion of it becomes energy sources which generate wind, waves, and ocean currents. It is also used by plants for photosynthesis and stored as biomass energy. Fossil fuels are also formed as a result of solar energy stored underground and can be said to be one of the forms of storing past solar energy.

Table 3 Amount of Solar Energy Reaching the Earth

		Amount of energy (tons in oil equivalent)
Sunlight Solar energy irradiated onto the Earth: 174 PW Practically available solar energy: 1 PW[1)]		
Available solar energy (per year)		7.53×10^5Mtoe
The World's annual supply of primary energy (2008)		0.12×10^5Mtoe
Fossil fuels	Reserves (2007)	
Oil	1237.9 billion barrels[2)]	1.68×10^5Mtoe
Coal	847.5 billion tons[2)]	5.87×10^5Mtoe
Natural gas	177 trillion m^3[2)]	1.84×10^5Mtoe
Uranium	5.47 million tons[3)]	0.75×10^5Mtoe
Total energy reserves		10.14×10^5Mtoe

1) Energy Policy (1991): pp. 386-391, B. Sorensen
2) Statistical Review of World Energy 2008, BP
3) Uranium 2007, OECD/NEA-IAEA

If we can make more efficient use of solar energy, we should be able to live without depending on fossil fuels. A society in which we can really achieve this is a "sustainable society that is based on the use of solar energy."

Table 3 compares the amount of energy provided by sunlight and by fossil fuels in oil equivalents. If mankind can use ca. 0.5 percent of the solar energy reaching the Earth, that would amount to be 7.53×10^5 Mtoe[(41)] annually. This is almost equivalent to the energy held in the reserves of energy resources such as fossil fuels and uranium (10.14×10^5 Mtoe) and more than 60 times the energy provided by the primary energy sources that we use annually. As such, the amount of solar energy reaching the Earth is gigantic.

(2) Solar Energy and the Sustainable Society

In the sustainable society based on the use of solar energy, most of the energy required for our daily living is supposed to be provided by the solar energy reaching the Earth. We intend to build a society that will change our lifestyles and socioeconomic structures dramatically by aiming to make proactive and efficient use of the solar energy available across the globe, rather than just creating a low-carbon society.

We think that unless we realize a sustainable society based on the use of solar energy within the next 100 years, we cannot fundamentally solve the global warming problems nor solve the problem of resources. It might be very difficult for an ordinary person on the street to have a clear vision of a solar energy-based society now. A sustainable society based on the use of solar energy

is built upon realizing the following measures as shown in figure 29: use of energy resources other than fossil fuels; introduction of production systems and lifestyles that will make efficient use of solar energy; and recognition and use of the blessings of the Sun and nature in all regions of the Earth.

In a sustainable society based on the use of solar energy, people will make extensive use of renewable energy sources, including sunlight, solar heat, wind and hydraulic power, biomass, geothermal heat, and tidal power. To build such a society, we need to make a dramatic social transformation. On the technological front, we assume a society that has made substantial technological innovation, raised our power distribution efficiency and minimized energy losses during power transmission with the use of smart grids and with installation of superconductive power transmission systems. We assume also a society that has achieved effective use of energy through power storage technologies such as highly efficient storage batteries.

One requirement for building a sustainable society based on the use of solar energy is that we substantially change our lifestyles so that we can make efficient use of solar energy. And further, everyone in the society is assumed to fully recognize the value of the blessings of the Sun and nature. Even now, we receive many blessings from the Sun in our lives, but we seldom are conscious of or feel grateful for those blessings. In order to achieve a sustainable society based on the use of solar energy, it is essential that all members of the society nourish a spirit that values the blessings of the Sun.

Figure 29 Requirements for a Sustainable Society Based on the Use of Solar Energy

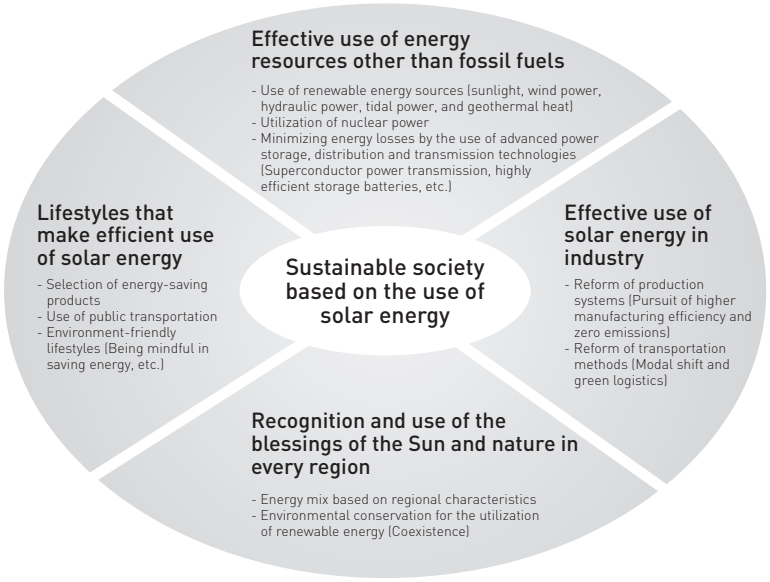
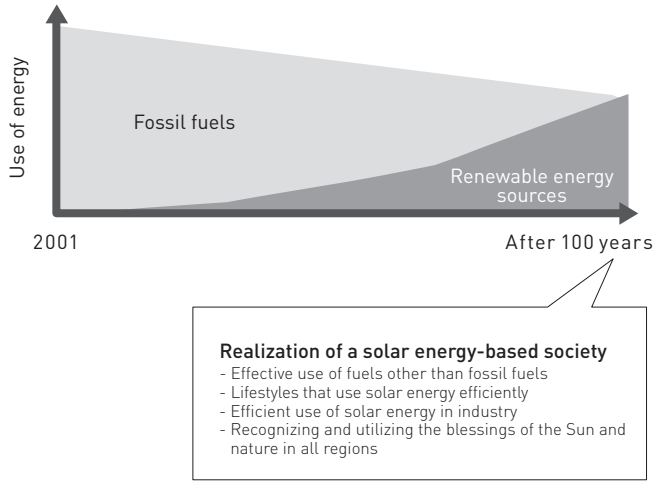


Figure 30 Vision of a Solar Energy-Based Society



There are many issues to be solved in realizing a sustainable society based on the use of solar energy, but by setting a long-term target date of 100 years from now, we have a realistic chance of succeeding. It is vital that we formulate a design for the future full of ideas and begin implementing them from today.

We cannot build a solar energy-based society overnight: it is an ideal image of a society 100 years from now. Figure 30 illustrates an image on the energy front for such a society. To realize such a society, it will require long-term and large-scale innovations in technological developments and in the transformation of our social institutions. That will take a long time, and we must start preparing from now step by step. Until such a society is established, we will have to continue to depend on fossil fuels and nuclear power for energy, and must devise better ways of supplying and using energy in the transition period.

Further development of renewable energy technologies

Technological development of renewable energy sources, such as sunlight, solar heat, wind power, hydraulic power, biomass, geothermal heat, and tidal power is continuing across the world. In Japan too, universities, research institutes, and companies are actively promoting research, and they are supporting R&D demonstration and field tests, the introduction and promotion of new energy sources and the technology of energy conservation.

There is a range of renewable energy technologies, some of which are now in the R&D phase and some soon to be commercialized, and they are all expected to help reduce or eliminate CO_2 emissions. They are, however, expensive and have not yet prevailed. It is expected that further technological development will raise the energy conversion efficiency of renewable energy sources, which will help boost their commercialization.

In order to realize and sustain a solar energy-based society, just developing renewable energy technologies will not be sufficient. Renewable energy technologies such as solar power generation and wind power generation are inherently variable that power output varies greatly with weather and/or sunshine conditions. So, to effectively distribute electricity generated from those sources, it is necessary to develop technologies to store the generated electricity and to distribute electricity without fluctuations in output. Among those innovative electricity storage technologies, there is one that would significantly raise the efficiency of existing storage batteries, such as the use of carbon superfine particles in lithium secondary batteries, and another that would store the electricity obtained from solar photovoltaic power generation in superconductive flywheels during the day and then supply the stored electricity during the night. Hydrogen is used to generate electricity in a fuel cell, and is another means to store electricity, and thus technologies to manufacture, transport, and store hydrogen are regarded as key technologies in its utilization.

As an innovative power transmission and distribution technology, there is the superconductive high efficiency power transmission system that uses high-temperature superconductive materials. If these materials become available at more reasonable prices, it will become possible to establish a power transmission system around the globe. Under such a system, power generated in the Sahara Desert could be transmitted to Asia and electricity generated from sunlight could be used without worrying about the changes in weather and sunshine hours. In addition, smart grids that use IT technologies would make it possible to distribute electricity more efficiently by responding to changes in the amount

of power generated effectively.

In developing new technologies, it is important to pay attention not only to technologies that are almost certain to be commercialized in the near future, but also to basic research in "future technologies" that could come into use a century from now. Technological development should be conducted from the long-term viewpoint of sustaining a global society even for those for whom progress in research has not been easy to achieve due to extreme difficulty. Such technologies include the use of solar energy in space, nuclear fusion technologies, and superconductive power transmission technologies.

Great innovations in science and technology are needed to move away from a lifestyle depending on fossil fuels. To this end, we need to create a new science and technology that will not only pursue short-term industrial benefits but also the long-term benefits for the whole Earth. It is true that highly effective and efficient technologies could be developed even in the short term through competition in the market. But to create science and technology that can contribute to sustaining the Earth and mankind, it is essential for governments to promote research and development and supply the necessary funding for them based on clear policies with firm intent, and it is evaluation from a long-term viewpoint that will result in beneficial fruitions.

Improving and upgrading existing energy technologies

● Full-fledged energy conservation and the global prevalence of energy conservation technologies

In preventing global warming, it is important not only to promote the use of renewable energy technologies but also to change our society into one that does not waste energy. In order to achieve that, we must have energy conservation technologies that prevail across the world.

To conserve energy, it is important to increase the total efficiency of the energy consumption system. To build such a system requires promoting the use of energy and resources in a cascade and having multifunctional production processes. It is also important to establish a flexible energy supply system that supplies energy according to the quality of electricity required by classifying products into those that need a stable supply of high-quality electricity such as information devices, and those that do not need a stable supply. Energy conservation could be done most effectively when it is done at locations near to the final consumption site, and thus it is important to promote this type of energy conservation steadily and continuously.

Energy conservation technologies are currently being developed in various countries across the world, and it is important for the international community to continue pursuing the development of these technologies to build a sustainable society based on the use of solar energy. The technologies thus developed need not only be used in the developed countries but also have to be transferred to developing countries for global prevalence. Developing countries will build more social infrastructure to achieve further economic development. Once large facilities, such as power plants and ironworks are constructed, it will be difficult to replace them with new ones, even if the facilities initially constructed are not very energy-efficient. It is therefore important for those facilities to be built using the most efficient and advanced energy conservation technologies, and that is why technology transfer to developing countries must be hastened. By accelerating the introduction of energy conservation technologies to countries and areas where

energy efficiency is low, developed countries will be making a great contribution to the effective use of energy resources and to reduction of CO_2 emissions on a global scale.

For energy conservation technologies to spread globally, it is necessary to solve the problems related to intellectual property rights and cost-sharing, but it is also important to build the infrastructures necessary for developing countries so that they can accept those technologies, including human, organizational, and institutional foundations. Developed countries must support developing countries in establishing infrastructures for them to accept new technologies through international technological assistance projects and other means, while ensuring that developing countries can make continuous use of the transferred technologies on their own.

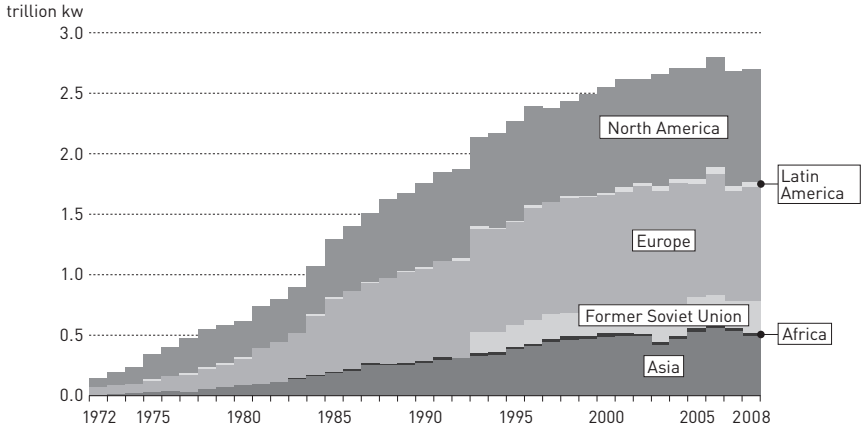
Effective use of nuclear power

It will still take time before we can rely fully on renewable energy for our daily lives. During the transition period, we need to make effective use of conventional energy sources. Among those energy sources, nuclear power seems to be potentially the best for the time being with its huge capacity to supply, even though the cost of constructing, maintaining, and disassembling a nuclear power plant is high.

Nuclear power generation does not emit CO_2 and could help mitigate substantially the restrictions that are coming from resource and environment aspects. Figure 31 shows the trends in the world's nuclear power generation output. In Europe and in the Americas, the output from existing nuclear power plants has been proactively increased and the amount generated is on an upward trend. In Asia too, the number of nuclear power plants and the amount of power generated has increased. Among the developing countries in Asia in particular (China, India, etc.), to achieve the stable supply of energy necessary to support economic growth, it is forecast that there will be a significant expanse in the introduction of nuclear power generation.

However, there are still issues to be resolved in using nuclear power. The safe and peaceful use of nuclear power plants should be ensured and appropriate measures should be taken to treat radioactive waste. Unless measures and policies are taken to ensure full public understanding, effective utilization of nuclear power will be difficult. For that purpose, along with developing a safe new nuclear power generation technology, it is necessary to promote public understanding of its use by establishing international

Figure 31 Trends in Nuclear Power Generation in the World (By Region)



Based on Annual Energy Report (2009), Japanese Ministry of Economy, Trade and Industry
(Original data: Nuclenonics Week, The McGraw-Hill Companies)

cooperation among countries for its safe and peaceful use, and by continuing negotiations in the reduction of nuclear weapon stockpiles. In Prague in April 2009, President Obama of the United States announced his commitment to nuclear nonproliferation and the elimination of nuclear weapons, which is expected to help promote international discussion on the peaceful use and international management of nuclear power. For the further use of nuclear power, comprehensive research into its safe and peaceful use, and provision of talented human resources who can support its use are the most important challenges.

Effective use of fossil fuels

Fossil fuels account for about 80 percent of our primary energy supply currently and will remain the most important energy source on a short- to medium-term basis. Until we achieve a sustainable society based on the use of solar energy, we cannot help but to depend on fossil fuels; but we should do so by choosing methods that minimize emissions of CO_2. For example, we can reduce CO_2 emissions, even with the continuing use of fossil fuels by the following methods: increasing the use of natural gas, which has per-unit CO_2 emissions that are smaller than for oil and coal; adopting coal gasification technologies in using coal and increase efficiency compared to conventional coal fired power generation, thereby substantially reducing CO_2 emissions; and introducing a cogeneration system, which generates steam using waste heat from power generation, and uses the generated steam to increase the energy efficiency and reduce CO_2 emissions. In this way, we can reduce CO_2 emissions by adopting technologies that make better use of fossil fuels. Another promising option to reduce carbon is to develop carbon capture and storage (CCS) technology to capture and store the CO_2 generated in addition to improving the electric power generation efficiency.

There are still technological problems to be solved with CCS, including those related to the behavior of stored CO_2 and its impact on the environment. In promoting the technology, it is therefore essential that more feasibility studies be conducted to assess its environmental impact and safety, which will in turn help improve public acceptance of the technology.

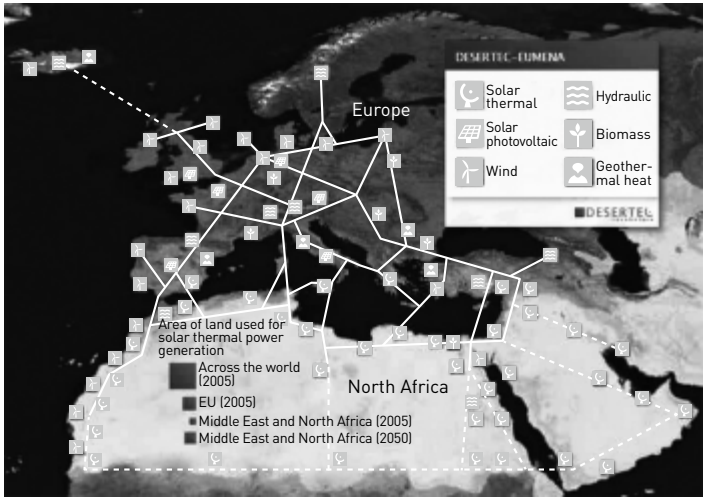
Examples of the effective use of solar energy

Various international organizations are proposing images and concepts for building the ultimate sustainable society based on the use of solar energy.

For example under the IEA Photovoltaic Power Systems Programme (IEA PVPS),[42] which consists of 19 countries including Japan, the United States, European countries, and two organizations, an international project to look into the possibility of installing a very large scale photovoltaic system (VLS-PV) with an output of 100,000 to 1 million kW in unutilized land such as a desert is now under way. This project (IEA PVPS Task 8), for which Japan serves as the Organizing Agent, published a report on its activities titled Energy from the Desert in September 2009 and in the report proposed a VLS-PV roadmap, a super long-term future vision for 2100. The roadmap was made in reference to a scenario proposed by the German Advisory Council on Climate Change that two-thirds of the world's primary power will come from solar energy by 2100. The roadmap proposes to cover one-third of our energy needs with solar photovoltaic power generation and another one-third with solar thermal power generation.

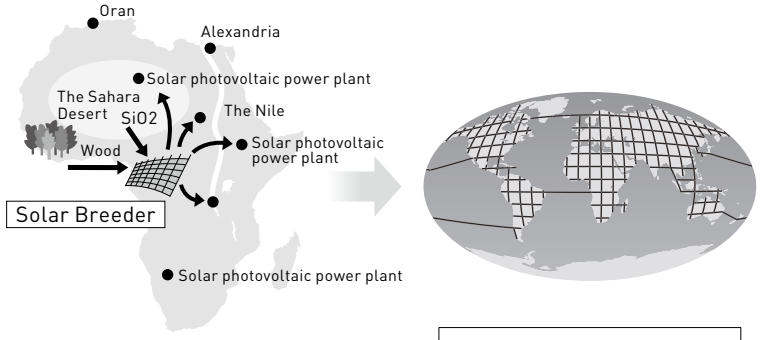
There is also an industrial initiative, known as the DESERTEC

Figure 32 DESERTEC Industrial Initiative



Based on reference materials provided by the DESERTEC Foundation (http://www.desertec.org/)

Figure 33 Sahara Solar Breeder Plan



Constructing silicon factories and photovoltaic power plants in a multiplicative manner (to be doubled every two years) for the effective use of desert sand and sunlight

Solving problems related to output variations and electricity storage at photovoltaic power plants by establishing a high-temperature superconductive direct transmission network on a global scale

Source: Based on the support materials for Press Conference of President Dr. Kanazawa of the Science Council of Japan

Industrial Initiative, on which agreement was reached on July 13, 2009 by 12 leading companies in Europe including Siemens and Deutsche Bank to promote the use of solar energy. As shown in figure. 32, this project is intended to supply 15 percent of the electricity demand in Europe by transmitting power generated at large-scale solar thermal power generation facilities built in the Sahara Desert and other locations at a total cost of 400 billion Euros.

There is also a very ambitious proposal named the Sahara Solar Breeder (SSB) Plan, which is based on the assumption that if there comes a time when solar energy utilization technology and power distribution technologies using superconductivity make further progress, it will become possible to build solar photovoltaic power generation facilities in the desert and meet the global demand for electricity. In the G8 academic summit held in Rome in March 2009, the Science Council of Japan proposed the Sahara Solar Breeder (SSB) Plan towards establishing a global clean energy superhighway (Fig. 33). This plan aims to generate electricity from solar cells installed around the Sahara. The solar cells will be manufactured using some of the generated electricity and silica sand available in infinite amounts in the desert. If implemented, it will enable the multiplicative production of solar cells using surplus electricity. The electricity generated by the solar cells will be supplied to the surrounding areas to improve the living standards of the local people, and eventually the electricity will be supplied all over the world through a superconductive network. This is a gargantuan project.

3 Changing Lifestyles

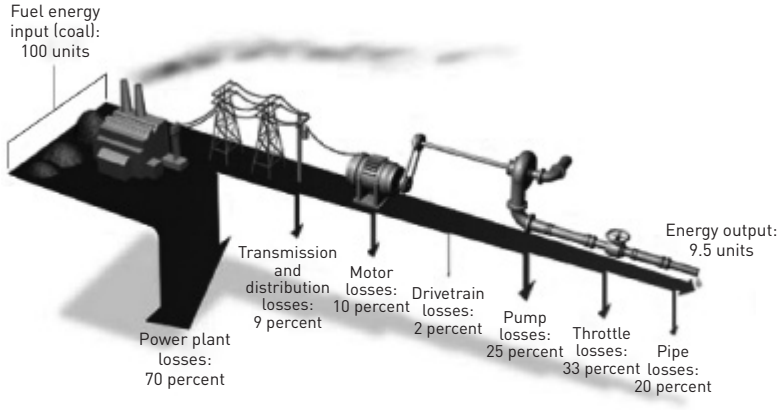
(1) Our lifestyles need to change

It is we humans that have caused the present global environmental problems. Therefore unless human beings change their traditional ways of thinking and lifestyles there will be no solution to the global environmental problems. Thanks to the development of science and technology and the market economy, our life has become materially rich and has improved in its convenience. However, this wealth and convenience are supported by consuming vast amounts of resources and energy and releasing large amounts of waste(43) into the environment. In fact we need to consume resources and energy to sustain our lives, but when it becomes excessive, then vast amounts of waste are generated, causing damage to nature. Excess use of resources will at the same time accelerate their depletion. Unless we change our current lifestyles, our resources will run out and the global environment will deteriorate, and we will lose the foundation for our survival. We need to re-recognize that we should stop pursuing material wealth needlessly and that what is important is the wealth of the spirit.

For most of us when we review our present lifestyles, it could be said that we may not be conscious enough of the fact that our lives depend on the blessings of nature. In fact, however, we depend on nature's rich biodiversity for our food, clothes, and housing. When agricultural land is expanded to produce more food, this contributes to a loss of biodiversity. Land has been developed to produce food and feedstuffs, tropical rain forests have been cut down for pastureland and to produce palm oil, and mangrove forests have been cleared to produce shrimps. As a result, we are facing a loss of biodiversity. Moreover, because of fishing methods that do not address sustainability of fish species, populations of large fish species have been decreasing.

A lot of energy is consumed by industry and also by us in our individual lives. In Japan, household energy consumption has been steadily increasing, and compared to when the first oil crisis occurred 35 years ago, consumption has more than doubled. It is now time for us to seek a way to curb our energy consumption without sacrificing the convenience and comfort of our lives. As a

Figure 34 Effect of Higher Efficiency at the Downstream End



Reference: **Effect of Higher Efficiency at the Downstream End by Dr. Amory B. Lovins**

From the power plant to an industrial pipe, inefficiencies along the way whittle the energy input of the fuel—set at 100 arbitrary units in this example—by more than 90 percent, leaving only 9.5 units of energy delivered as fluid flow through the pipe. But small increases in end-use efficiency can reverse these compounding losses. For instance, saving one unit of output energy by reducing friction inside the pipe will cut the needed fuel input by 10 units. The effect of saving at the downstream end is thus huge. Also, it becomes possible to make all the upstream components smaller and simpler.

Source: Based on a lecture given by Dr. Amory Lovins at the time he received the 2007 Blue Planet Prize

first step towards a solar energy-based society, we must change our lifestyles as individuals and as households.

The importance of using energy more efficiently through changing lifestyles has been made clear theoretically. Dr. Amory B. Lovins, who is an energy scientist, has been insisting on the importance of energy conservation by consumers at the "downstream end" from the viewpoint of resource use efficiency and improving economical operation through optimization of the entire supply system (Fig. 34). For example, in the supply of electricity, as a lot of electrical energy is lost before it reaches the user, if the end user consumes the electricity delivered more efficiently, it will lead to substantial energy conservation across the entire supply system. Further, by saving electricity and contributing to improving the system's efficiency, consumers will also increase their awareness of the importance of resource conservation.

As Lovins indicates, energy conservation at the "downstream end" is important. Changing our lifestyles is one solution to global environmental problems that we can start now, and if all people in the world change their lifestyles for the better, the effect will be huge. Therefore, in order to realize a solar energy-based society, it is indispensable that we change our lifestyles.

(2) What Should We Seek in Future Lifestyles

What is wrong with our present lifestyles and how should we change them? As we have discussed, our lives, rich in material wealth and high in convenience, are supported by mass production, mass consumption, and mass disposal, and they are having a damaging impact on nature. What has led us into such mass-producing and mass-consuming lives? Can we say that the fundamental cause of such a way of life is that we set off a trend where we humans began to lose consideration for nature and for others and came to think only about themselves and to not care for others? Was it a result of excessive individualism and intensive market competition formed in the course of meeting our material requirements? These trends seemed to spread not only in our individual lives but also in our corporate activities leading individuals or corporations to focus only on pursuing profit just for themselves or for their companies

The individual pursuit of profit, however, has not brought optimal profits to the globe as a whole and has instead caused global environmental problems, making people aware of the finiteness of the Earth and triggered a global crisis.

We must create a solar energy-based society on the Earth where things have limits, so that all living beings including mankind can live to have vibrant lives. For that, we must lead our daily lives and conduct our business activities in harmony with nature. It is important when using energy and resources to appreciate them as the blessings of nature. And for humans who should support such thinking need to recognize that they can only sustain their lives thanks to nature and that they are supported by its blessings. Once they firmly stand on such ideas, the spirit of consideration for others and for nature will be brought forth and the importance of cooperation rather than competition will be recognized.

It is not very constructive to try to go back to the lifestyles of 50 years ago to reduce the damaging impact to nature of our socioeconomic activities by sacrificing the standard of living that we are now enjoying. We must review our lifestyles with a new way of thinking, discovering happiness in life with wealth of the

spirit, such as in cultural activities, instead of in material wealth. Then we will be able to find pleasure in touching others feelings and warmth, in valuing beautiful things and things with harmony and balance. In the past in Japan, the spiritual mentality of "having few wants" or "not wasting anything: MOTTAINAI" prevailed. Would it not be meaningful to revisit those values? A solar energy-based society will be realized by spreading new lifestyles in society based on values that are different from those of the past which pursued material wealth.

What should we do specifically to lead lives that are in harmony with nature, making better use of energy and resources as the blessings of nature? The United Nations Environment Programme launched its Sustainable Consumption and Production (SCP) initiative to change people's lifestyles, in particular in the aspects of production and consumption. SCP is defined as the "use of services and related products which respond to basic needs and bring a better quality of life while minimizing the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life-cycle so as not to jeopardize the needs of future generations." The initiative is intended to target economic development that will not result in more environmental pollution or the depletion of resources by improving patterns of consumption and production based on the concept of SCP. One of the specific measures we can take based on the idea of SCP is to spread the 3Rs, which are: reduce, reuse, and recycle waste to minimize the generation of waste and make effective use of resources to build a recycling-oriented society. Measures to implement the 3Rs have already been adopted mainly in the developed countries, where governments, companies, and citizens cooperate in constructing social systems to recover and sort/disassemble wastes as well as to recycle resources, and dispose of the remaining waste in an appropriate manner. Specifically, citizens are requested to pursue a way of life that minimizes the amount of waste generated from their households, and to cooperate in making effective use of second-hand products, and in the sorted recovery of waste for efficient recycling. On the production side, manufacturers are required to supply easily recyclable products, products that will consume only a small amount of resources and energy, and products that contain few hazardous substances.(44)

We need to understand the significance of building a recycling-oriented society, including the 3Rs, and review our behavior as consumers by having consideration for nature. In addition, we are expected to adopt consumption behaviors which choose products and services that will minimize the use of resources and hazardous substances as well as the emissions of waste and pollutants, because this kind of selective behavior by consumers will provide the driving force for the reform of manufacturing methods and improvement of final products.

(3) Education to Change Our Lifestyles

We are now enjoying materially rich lives thanks to economic development, but are we really happy? To realize a solar energy-based society, we must first understand that it is more important to be spiritually rich than to be materially rich. Education will play an important role in encouraging more people to understand that they can only become really happy by pursuing fulfilling spirit and not through mass consumption.

To change our lifestyles, it is essential to understand how our

lives are interrelated with the global environment. It is difficult to recognize the importance of global environmental problems in our everyday lives, and so we need to obtain the correct information and learn through education to enable ourselves to make the right decisions about global environmental problems. Human beings and the environment are interrelated in a complex way and there are still many things unknown to be clarified, and therefore it is crucial for us to continue to accumulate new knowledge and review how humans should behave in the natural world. Education on how to realize a society that coexists with nature is something that will enable us to nurture the ability to make appropriate decisions based on correct knowledge, and also to review how humans should behave in the natural world.

At present, the United Nations is implementing an initiative titled the United Nations Decade of Education for Sustainable Development, in order to provide education to "encourage changes that will create a more sustainable future in terms of environmental integrity, economic viability, and a just society for present and future generations." Under this initiative, countries are required to independently implement measures to "integrate the principles, values, and practices of sustainable development into all aspects of education and learning." This concept of education for sustainable development has much in common with our idea of a solar energy-based society which asserts that the entire world is interrelated and it is necessary to create a society based on cooperation, one in which people give consideration for others and nature. Education for sustainable development does not need to be something special. What is important is not to provide a lot of information or knowledge through education but to encourage individuals to develop the ability to collect the information they need, study that information, think independently to take the appropriate decisions, act based on those decisions, and review their behavior.

(4) Establishing a System to Promote Our Lifestyle Change

Providing people with opportunities to deepen their knowledge through environmental education and learning would not lead them directly into changing their lifestyles. The fact is that although people understand the importance of changing their lifestyles, it does not necessarily lead them to take action. In order for them to take action based on the understanding, it is also important to provide people with opportunities for them to actually practice the action. Providing more information and introducing more events on environmental conservation activities led by local communities and environmental activities conducted by various NGOs could enhance the systems for cooperation between governments, citizens, companies, and NGOs and provide relevant information to citizens. This will make it possible for them to become involved in environmental activities more easily.

It is also effective to encourage the use of certification labels/systems for products and business activities or to provide information on them, such as eco-labels and certification systems for environmental management systems. For example, we can consciously choose to purchase foodstuffs that have certification labels that identify them as fair trade products(45) or as eco-friendly marine products.(46) Also for products made from wood, we need to choose certified products(47) as much as possible. If a greater number of people purchase and use certified products, it will help

create a society that cares about living beings. In order to promote the movement, it is vital that the certification systems are verified on scientific grounds and can be relied upon by the consumer.

In addition to those already mentioned, environmental taxes, eco points, and offset, deposit, eco-fund, and regional currency systems are being studied and implemented as economic mechanisms to encourage people to change their behavior. It is important to ensure that these systems will work effectively in line with regional characteristics and eventually on a global scale.

4 A Vibrant Society Full of Diversity and Characterized by Cooperation between Urban and Rural Areas

As we have discussed, in the 20th century, urbanization took place globally and the society became one that mass consumes energy and resources, and it is now facing limits in a range of fields. In the process of urbanization, we have become disconnected from nature which is the foundation for us as biological beings, while our lifestyles have become excessively individualized, making interpersonal communications more difficult. As a result, both individuals and society at large have been losing vigor, which is perhaps a negative aspect of urban lifestyles. With the spread of urban lifestyles, opportunities to make contact with nature and interpersonal communications have been decreasing even in rural areas.

Both urban and rural areas which are facing the same problems should aim to become a solar energy-based society, be a cooperative society that sets nature as its foundation and cares for others and for nature. To this end, both in urban and rural areas, it is important to build a society where energy supply systems based on solar energy are introduced, nature is restored and conserved, and local inhabitants are provided with abundant opportunities to communicate and participate in social events. Although urban and rural areas have different features, it is also important to establish a relationship that will enable the vigor of both to be exhibited through cooperation making use of their individual features. With the increase in opportunities to have contact with nature and to communicate, both nature and humanity will be revitalized, and society will be transformed into one filled with diversity and vigor.

(1) Urban and Rural Areas Full of Vigor and Diversity

In the 20th century, cities were areas where people, industry and the economy concentrated to be centers for economic, logistic and industrial activities and came to serve an important role as strongholds to pursue higher efficiency and functionality. However, cities became places where a lot of energy and resources were consumed, and with their growth, the natural environment was replaced by artificial structures and they gradually became disconnected and isolated from nature. With too much focus put on industrial and economic functions, isn't it the case in most cities that people living and working there tend to have less chance of coming to feel nature close at hand or are even forced to have an unpleasant life? Furthermore, due to economic globalization and the spread of uniform urban lifestyles, not only biological diversity, but also human and regional diversity is being lost and now the dynamism of our cities is on the decline.

On the other hand, rural areas have been designated as places to supply agricultural products for food and a labor force to support economic development in urban areas. Forests were felled to expand farmland in the price competition for agricultural products based on economic principles, and the soil has become degraded due to the overuse of fertilizers and agricultural pesticides in pursuit of higher productivity. The natural environment that remained cannot be managed adequately due to the shortage of human resources, and as a result, impoverishment in rural areas is now significant.

The concept of a solar energy-based society which we are proposing here entails the creation of urban and rural areas full of diversity and vigor by restoring the relationship between human beings and nature.

Development of vibrant cities

●Structural transformation to build a solar energy-based city

Given that a lot of energy and resources are consumed in cities, in order to realize a solar energy-based society, it is necessary to change city infrastructure to one that is supported by solar energy and the blessings from nature created by the sun. To make this kind of change, in addition to fully utilizing renewable energy sources, such as sunlight, wind power, and biomass, with the use of highly efficient energy devices and by conserving energy by adopting highly heat-insulating materials for buildings, the efficiency in the use of energy and resources must be raised individually. And in the long run, it also becomes necessary to raise efficiency by changing the urban infrastructure, which could be achieved by implementing the following measures: controlling traffic demand by shortening the distance between residential and business areas and promoting the use of land for multiple purposes; raising the efficiency of transportation systems by measures such as modal mix; and establishing and improving a system for the circulative use of resources and energy.

Realization of a solar energy-based city where energy and resources are used in an efficient manner without waste will provide a model for the creation of an energy- and resource-efficient community.

●Creation of a "nature corridor" as a core component of a solar energy-based city

When a solar energy-based society is established in a city, that will not only help conserve the global environment, but will also enable citizens to lead diversified and vigorous lives by being an integral part of nature. By having more frequent contact with nature, people who live there can recover their humanity and feelings to give more support to each other.

In building a solar energy-based city, to reintroduce nature into a city, creating a "nature corridor" as a core component of the city structure would be an effective way. For example, natural rivers and lakes located in the city could be improved to recreate continuous habitats that extend to the ocean to provide living space for aquatic organisms. At the same time, green areas and parks could also be improved to connect the green forests and woods that had been isolated, so that creatures living in the mountains and hilly areas can also live in the city. In these ways, it will become possible to create a city where people can come in contact with the natural world.

●Solar energy-based city where people can communicate and collaborate

A solar energy-based society is where people respect each other and is a society rich in diversity and vigor. For people to continue to enjoy the great blessings of nature, it is necessary to face nature with "consideration" in mind, and to build relationships of trust with each other. In an urban society where efficiency is overvalued, it is all the more important for people to trust each other. Cites could be revitalized to provide a home for a humane and vigorous society if interpersonal relationships in the city are strengthened and communities are established where people can actively participate in urban development. People will have various opportunities to participate in the society by making new exchanges and establishing new communities, and then individuals will become more vigorous through their participation in the society.

If cities introduce and manage environmental activities, such as forestation, gardening, and the creation of parks in which their citizens can participate, it will help restore and build nature within the cities and will also provide citizens with opportunities to make new exchanges and communities through voluntary activities. Cities in which citizens are actively making new exchanges and creating new communities by taking the initiative in activities to conserve and use the green environment will play an important role, not only as efficient and vigorous centers of industrial and economic activities, but also as cultural centers and attractive residential areas. People will be able to build relationships of trust and lead fulfilling and comfortable lives by being in contact with nature in their daily lives.

Creation of a Sustainable Natural Resource Circulation Regional Zone

●Creating a model for a solar energy-based local community

In realizing a solar energy-based society, it is essential to maximize the use of renewable energy sources, particularly the use of solar energy, as already mentioned. Rural areas have abundant natural resources, including not only sunlight but also wind power, medium and small hydraulic power, biomass, and other renewable energy sources. In addition, these areas have large tracts of land and they therefore meet all the conditions for using energy resources effectively. Because rural areas are not as densely populated as cities, with people living dispersed over a wide area, it will bring great advantages for them to adopt a distributed and independent energy supply system using renewable energy sources.

From a long-term viewpoint, it is extremely important to regard rural areas as model areas for the maximum use of renewable energy sources and develop them into sustainable energy societies that do not impose a load on nature.

●Expectations for Sustainable Natural Resource Circulation Regional Zone

In a solar energy-based society, the natural environment is highly

valued as an essential foundation for the lives of human beings and other living beings. Rural areas, especially agricultural communities, are blessed with precious natural environments. Agricultural communities play an important role in producing the goods and services for people to meet their requirements for food, clothing, and housing by utilizing the natural environment. At the same time, the natural environment, on the other hand, is a "capital" that should be maintained and utilized by the whole of the society, and thus the agricultural communities are expected to serve an important role in conserving the precious natural environment through their socioeconomic activities and community building efforts.

However, it is economically difficult for a rural area or an agricultural community on its own to bear the responsibility for conserving the natural environment. It is also necessary for cities to share the burden of nature conservation, based on the idea that the natural environment is a common asset for the whole society. For example, watershed taxes are designed to impose proportionate burdens on users of river water to protect nature in watershed areas for the purpose of conserving nature in the waterhead area for sustainable water use. The taxes collected are used to maintain and manage the forests which serve an important role in watershed protection. Supplying food through agriculture could be considered as an act utilizing the natural environment, and thus it could be considered appropriate for urban dwellers to bear a portion of the cost of maintaining the natural environment to produce and supply food.

In the future, it will become important to establish a system for urban and rural areas to share the burden of maintaining the natural environment appropriately as a common asset of the society. It is also important to create a "Sustainable Natural Resource Circulation Regional Zone" as a scheme to conserve the natural environment through cooperation between urban and rural areas. A "Sustainable Natural Resource Circulation Regional Zone" means a zone comprising a core city and the surrounding agricultural and nature-rich areas, which are strongly linked economically and through nature. By establishing such a zone, it will become possible to manage the entire region in a comprehensive manner. And by promoting the viewpoint of utilizing nature's blessings effectively in the zone, it will also become possible to establish a society where local natural resources and renewable energy resources are used in harmony with nature.

● Revitalizing local communities

Before modernization, people lived in the same areas for generations, supporting and helping each other based on shared values. Due to the development of cities following modernization, people living in rural areas, in particular younger people, moved to urban areas to work, which resulted in the decline of vitality in rural areas.

In order to incorporate rural areas into a Sustainable Natural Resource Circulation Regional Zone and transform them to be more attractive, it is first necessary to encourage young people, who should play a central role, not to leave the area for the city. But younger people should not be forced socially or psychologically to make that decisions. They must decide on their own to choose a life in an agricultural community and practice agriculture while protecting the natural environment as a fulfilling way to live. This would be possible only if urban and rural areas cooperated and if cities were willing to share the economic burden with rural areas for that purpose. It is only when such an economic support system for rural area by the cities is built and the system functions, that it becomes possible for people in rural areas to live in nature and for urban and rural areas together to form a

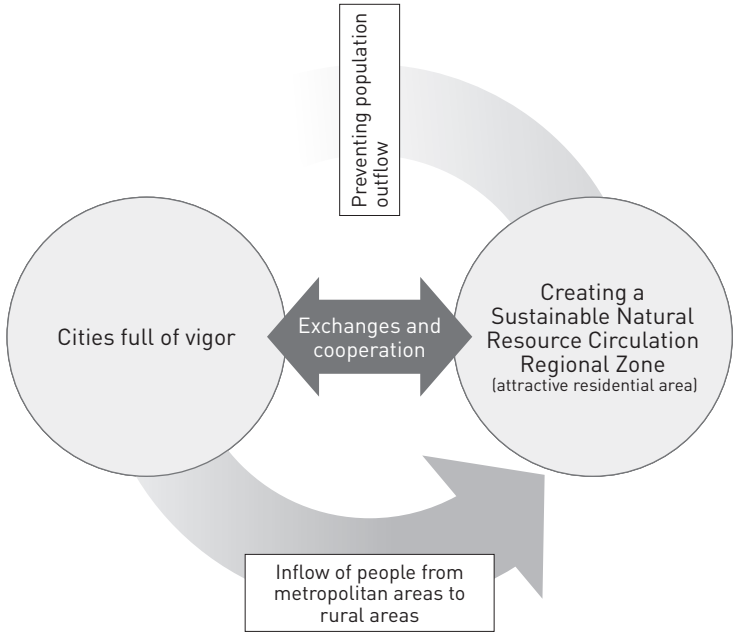
Sustainable Natural Resource Circulation Regional Zone in which people can continuously receive nature's great blessings. This will in turn revitalize local communities in rural areas.

(2) Cooperation in Creating an Independent Sustainable Natural Resource Circulation Regional Zone

As the solar energy-based society sets the natural environment as a social capital for all of mankind, it relieves people from the dilemma that their activities may damage the foundation of their own living. Rural areas are rich in nature and their economic activities are based on uses of the natural environment such as agriculture. As the natural environment is a socially common capital, it can be thought that rural areas are being entrusted with preserving the capital by the whole of the society. If some rural area finds it difficult to sustain itself economically, and still maintain the capital of the natural environment entrusted by the whole society, it is necessary to support the area's economic activity through cooperation with cities and other rural areas (Fig. 35). Through cooperation, rural and agricultural communities will be able to form a Sustainable Natural Resource Circulation Regional Zone, and this could be an effective means of creating a regional community capitalizing on its unique local resources.

In their efforts to create a solar energy-based society based on their respective features, urban and rural areas are expected to fulfill the following roles: cities are expected to provide people with places where they can lead fulfilling and vigorous lives and rural areas will provide nature-rich and attractive residential areas. Through exchanges and cooperation between urban and rural areas, both cities and agricultural communities will be able to create communities that take advantage of their unique characteristics. And with rural areas becoming more attractive as residential areas, the flow of people from rural to urban areas will decrease and might even be reversed. In a solar energy-based society, the gap between urban and rural areas will be narrowed and they will provide an equally attractive residential environment.

Figure 35 Building a Society Full of Diversity and Vigor through Cooperation between Urban and Rural Areas



5 Improving the Social System and International Cooperation

(1) Strong Commitment from Politicians and Governments

To realize a sustainable society based on the use of solar energy, it is important to reform our social institutions in addition to making technological innovations. In changing our social institutions to be relevant to the environment, it is essential that governments do so with a strong commitment and with a long-term vision. All citizens must take an interest in the politics and actions of their government and participate in the political process that will take concrete actions in realizing a solar energy-based society. It is imperative that politicians and governments formulate plans and uphold forward-looking targets from a long-term viewpoint and promote them by implementing various measures. Moreover, they are expected to set R&D targets in realizing a sustainable society and to help universities, research institutes, and corporations to develop the base technologies as well as other important technologies necessary to attain their targets.

It is also vital that governments implement specific measures that will lead to building a sustainable society based on the use of solar energy. The governments of some countries have already implemented measures in a range of forms, including both (1) market-based measures such as those that support the installation of the necessary equipment (subsidies, tax breaks, and low-interest financing) and that support the operation of the equipment (quotas, bidding, feed-in tariffs, and preferential tax treatment systems); and (2) other measures such as simplification of administrative procedures and issuing guidelines. For example in Germany, grid power suppliers are mandated to purchase all electricity generated from renewable energy sources which is relatively expensive at fixed prices, and the increased costs are put onto the electricity charges paid by the general households and companies. In Europe, the EU launched a regional CO_2 emissions trading system in January 2005, and it has become the world's largest emissions trading system in which multiple countries are participating. It must be noted that these measures can be implemented only when politicians and governments are strongly committed to the implementation.

(2) International Cooperation in Building a Solar Energy-Based Society

Global environmental problems are problems that cause damage to the entire world. In order to solve these problems, it is essential for countries not to act based on their self interest, but to deal with them in alliance with the entire world, thereby requiring international dialogue and cooperation. Among those that could be considered are technological, financial, and political cooperation.

With regard to technological cooperation, energy conservation technologies must be further disseminated as discussed before, and there are also a lot of other technologies that must be spread across the world. It is important to establish the foundation for international technological exchange and build a global framework for making such exchange so that the world's most advanced technologies can be introduced to a wide range of areas, while

giving due consideration to patents and other issues.

Measures to deal with environmental problems tend to be put off in developing countries due to financial problems or because of their national policies to give priority to development. For developing countries to move forward with anti-global warming measures and take a step towards realizing a sustainable society based on the use of solar energy, external financial support is indispensable.

Several various international funds for anti-global warming measures have already been established, including the Clean Development Mechanism (CDM) and the Special Climate Change Fund. While thinking of a more effective way to use these existing funding mechanisms, adding additional funding mechanisms will enhance realizing a solar energy-based society in a global scale.

Professor Hirofumi Uzawa, who won the Blue Planet Prize in 2009, proposes a proportional carbon tax system as a means to mitigate the gap between the developed and developing countries. This system is designed to impose carbon tax with its rate in proportion to the per-capita national income. And along with imposing the tax, the system is designed to establish a new International Fund for Atmospheric Stabilization where participating governments contribute a certain percentage of the tax income obtained through the system and then distribute the contributed money according to certain rules. This proposal is based on the idea of environmental fairness. Besides this, the International Monetary Fund (IMF) has proposed the idea of imposing an "international solidarity levy" to secure funds to tackle global environmental problems, and the levy will be imposed on economic activities beyond national boundaries. At present specific taxation methods are being studied, including taxation on currency trading and international transportation activities.

As we have experienced in trying to execute the Kyoto Protocol, a sustainable society based on the use of solar energy cannot be achieved without international agreement and political cooperation. The problem here is that there is a kick in who caused the problem and who the victim is. It is the developed countries that have emitted most of the CO_2 and it is the developing countries that are usually more vulnerable to damages caused by global warming. However, if the developed and developing countries stick to their own interests and try to push through their own opinions only, global environmental problems will never be solved. We must therefore strongly urge our own countries to act to make a concerted effort to realize a solar energy-based society in the entire world. And for our future generations, we have to make practical moves to realize a solar energy-based society in the entire world, not by having nations sticking to their own interests but by letting them think about the benefits to the world as a whole and cooperate regionally, bilaterally, and multilaterally. Moreover, as citizens we must urge the United Nations to reform itself into an organization that can lead the world to cooperate in realizing a solar energy-based society by encouraging its member states to put global interests over their own national interests.

Final Chapter

Restoring a Vibrant Earth

Realizing the Blue Planet

We are now facing a crisis caused by global environmental problems. The only way to overcome this crisis is to regain the vibrant Blue Planet through realizing a solar energy-based society.

1 Restoring a Vibrant Earth Full of Life

What kind of a future should we go for? Keeping the global environment sound means that not only humans but all living beings on Earth will be in existence to lead vibrant lives. It is the duty of the present generation to ensure that by 100 years from now the Earth will be restored to such a state. Here we would like to explain the image of the future we should go for.

Life on Earth would not exist without the Sun. Solar energy reaching the Earth in vast amounts as sunlight and heat has given birth to plants, animals, and various other living beings and supported their lives.

In order to restore a vibrant Earth full of life, we must change our traditional notion that human beings are special and superior to other creatures and that we can therefore change the natural world as we wish and use its resources limitlessly. We must recognize that human beings are also biological beings who like all other living beings are in a mutually dependent relationship with others and are supported by nature's blessings for their lives. Human beings are social beings and cannot live alone, separated from or in confrontation with others. In their human interpersonal relationships, it is their mutual restricted act to respect each other and not hurt others' positions, which will eventually ensure that your own self will be respected and not hurt by others.

In a place where an immense variety of living species including human beings maintain an appropriate balance in their mutual interdependence, each and every species can continue to survive full of vital force. By us humans coming to respect all life on Earth, it will become possible to avoid any further decrease in the diversity of species and gradually the Earth will be able to recover its vigor in a new balance of the ecosystems. For human beings to receive nature's blessings in a sustainable manner and pursue their activities, it is essential to limit their exploitation of the natural world to an extent that will not damage the circulation of natural resources and nature's ability to recover. To meet this requirement, it is necessary for us human beings to build new socioeconomic systems based on the idea that we should act in harmony with nature, which mean that our use of water, forests, and land should be done according to the circulation of nature without hampering these things. We also need to understand the complex relationship between nature and human beings and review fundamentally how humans should conduct their activities within the large framework provided by nature.

Let's start from looking at Energy which is indispensable for human activities. We proposed a concept of a solar energy-based society. There, as solar energy irradiates the whole of the Earth daily and as it is an energy source that everyone can use, its use will cause no change in nature and no damage beyond nature's ability to recover. Fossil fuels were also created by accumulating the blessings of the Sun's energy over geological time. But mass consumption of these fuels in a short time period has caused a rise in CO_2 concentration in the Earth's atmosphere, which is causing global warming. From now on, we need to stop relying on fossil fuels and aim to create a sustainable society based on the use of solar energy, which reaches all corners of the globe every day and its blessing is available to everyone.

The concept of a solar energy-based society does not simply mean a society in which the Sun provides the main energy source. It also means a society where human activities are conducted in

harmony with nature without damaging the resilience of nature. In our present societies, people tend to be excessively self-centered in their relationship both within their families and also outside their houses, interpersonal ties are becoming weak, and people do not care about or have enough consideration for others. As people have fewer opportunities to come in contact with nature, they care less and less about other living beings and nature. It is necessary to rebuild a diverse society based on the natural environment full of diversity and away from a society where interpersonal relationships have been weakened due to the concentration of populations in cities. The society should be transformed into one where people can mutually support each other through a local community with people having contact with nature. With urban and rural areas cooperating and people in the community collaborating in aiming for a society full of diversity and vigor in their own areas, a vibrant solar energy-based society will be realized and the Earth full of life will be restored.

2 New Ideas for a New Age

To restore the Earth full of life, it is important to rebuild a global society based on new ideas.

(1) Nature Provides the Foundation for Our Lives

Human beings are both social and biological beings. For the biological being, nature is the foundation of its life, and it lives as a tiny part of all living beings within nature. The biological being in nature is an entity that can not help being influenced by changes in the environment.

The activities we are involved in as social beings are causing the global environmental problems. In the belief that we humans could replace parts of nature with man-made things to make it more useful, we have been exploiting, consuming, and wasting natural resources by utilizing science and technology since the beginning of modernization and industrialization in the 18th century. It can be said that human beings have thus tried to control and conquer nature.

However, we as biological beings are part of nature and cannot live unless we act in harmony with it. Now facing global warming, a crisis for the natural environment, we cannot continue to cause damage to nature which forms the foundation of life for all living beings. We must recognize the fact that nature provides the foundation for all life on Earth, and we as biological beings cannot live without nature. Past economic development lacked such viewpoint, and it is this that has caused the global environmental problems.

In order to solve the global environmental problems, it is necessary not only to review the social institutions and the utilization of science and technology, but also to change the human-centered way of thinking. It is necessary to transform the mind into one that accepts that humans are just one of the biological species living and dependent on nature and recognize that maintaining a sound natural environment is a prerequisite to our own existence.

(2) Consideration for Others

Present global environmental problems can be said to be a by-product of the lifestyle of mass production, consumption and disposal and the mass use of energy and resources supporting them. In the background of such a lifestyle, there is the human-centered idea that human beings can control and exploit nature and live in a socioeconomic system that has the recent economic rationalism and competition-prioritized approach. Competition based on a market economy can provide creativity and vigor in socioeconomic activities, but at the same time it can lead to confrontations between people in the pursuit of self-interest and to hierarchical relationships among people, with the strong controlling the weak.

However, needless to say mankind cannot live without the blessings of nature. If humans try to control nature and change it beyond its ability to recover, there will be an abnormal change in the ecosystem. When such a change occurs, that will affect human beings who form a part of the ecosystem and eventually the survival of humans as biological beings will be threatened. Human beings are continuing to act in their own interest at the cost of nature, and that is not only diminishing nature's resilience but also threatening the very existence of humankind.

Human beings cannot live without depending on and cooperating with each other. For example in a family, the children would not be able to survive without the care of their parents. An agricultural community in the past was a typical social community. In our present society, however, interpersonal relationships have become complicated, with various conflicts of interest confronting each other. However, in this complex society which is becoming more complex, if many different entities are to live by having mutual relationships, it will be all the more important to care and have consideration for others and cooperate mutually, rather than have individuals confronting each other. The strong must put themselves in the shoes of the weak and must show consideration for the weak, and refrain from doing anything that the weak would not want. If we care and show consideration for others, they will someday also show consideration for us and will cooperate.

We need to state once more that the global society as a whole should have the idea in common that the human race is just one of the living beings that live with nature and that unless a sound natural environment is maintained the foundation for the survival of mankind will be damaged. Without care and consideration for a sound natural environment, the survival of mankind is in jeopardy. In order to restore the Earth to a planet full of life, it is necessary to make reforms in the current socioeconomic systems and interpersonal relationships. For good interpersonal relationships, it is important to respect one's identity, be minded to give consideration for others to understand their positions and to cooperate rather than confront each other. We must prevent confrontation and excessive competition from damaging our societies, and move forward to create a vibrant society where there

is a balance between competitive and cooperative relationships.

What the present generation should consider is not only the natural environment and the relationship between individuals. They have to have consideration for others in the bi- and multi-lateral international relationships as in between developed and developing countries and in generational relationship between present and future generations.

3 Approaches to Realizing the "Blue Planet"

The only way to restore the Earth to a planet full of life is to create a solar energy-based society by respecting nature created and maintained by the power of the Sun, and by making solar originating energy as the major energy source. To this end, we must live in harmony with nature and live by using sustainable energy represented by solar energy, which will in turn make it possible for all life on Earth to live vibrantly. Science and technology and the social institutions to realize a solar energy-based society must be those that can live with nature.

(1) Solving Problems by Gathering Wisdom from Both Science and Technology and Knowledge in the Fields of the Human and Social Sciences

Science and technology up to now has been utilized to bring material wealth and comfort, but they have also damaged the global environment. It is also true that the global environment cannot be restored to its original state without science and technology, which represents the accumulated wisdom of mankind. Thus it is important to develop and spread science and technology by adding a new viewpoint: science and technology for the conservation of the global environment. For research and development where technological development requires vast amounts of capital and human investment and cannot achieve results only by pursuing short-term fruits such as in developing new energy technologies,

special institutional measures based on a long-range viewpoint should be implemented.

In order to reexamine the relationship between human beings and nature, not only consolidation of cross-disciplinary wisdom in science and technology, but also assembling wisdom in the fields of the human and social sciences is needed. What is meant here by wisdom in the fields of the human and social sciences is something related to ethics and the social systems necessary for mankind to live as an entity in nature. It is important to try to solve the problem on a societal scale by systematizing such wisdom and by ensuring the use of the wisdom of both science and technology and of the fields of the human and social sciences. To meet this requirement, it will become more important to take a holistic approach to research by studying problems in a comprehensive manner through well-balanced interdisciplinary cooperation, rather than taking the conventional research approach that subdivides research fields into smaller ones.

(2) Creating a Social System to Nurture "a Mind of Consideration for Others"

Establishing environmental education and new lifestyles based on "a mind of consideration for others"

Global environmental problems emerged because human beings were ignorant of the environment. It is therefore of the utmost importance in solving the global environmental problems that all human beings, both children and adults, become aware of the importance of the problem and act to live their lives in a way that will not damage the global environment. To this end, environmental education must be provided not only at schools and lifelong education facilities but also at a range of public facilities, including museums and nature parks.

In pursuing such environmental education, the basis should be to nurture "a mind of consideration for others." Consideration for others starts from having respect for others. In those relationships among people and between human beings and nature, it is vital to recognize the importance of the mutual relation (the dependency) and it is on the basis of "consideration for others" that we can understand what kind of pain each individual behaviors can cause to others including nature.

In environmental education, it is therefore most important to develop human resources that can contribute to the development of a new society which ties the present to the future by looking at how people depend on and coexist with others and contemplating what kind of relationships to establish. Relationships between human beings and the natural environment are complicated and there are still a lot of things to be clarified, so it is necessary to constantly accumulate new knowledge and review the relationship between human beings and nature. And for this purpose, environmental education must be provided continually on any circumstances.

Nurturing "a mind of consideration for others" will lead to establishing lifestyles that allow people to lead sustainable lives in nature and build and maintain good coordinating and cooperative relationships with each other, moving out past mass-producing, mass-consuming, and mass-discarding lifestyles.

At present, the importance of reforming lifestyles has been emphasized by people working in different fields, and some individuals who have recognized this are taking action. Their actions, however, are still taken on an individual level and have not become

a movement in the society at large. We should now clarify how a new lifestyle based on "a mind of consideration for others" should be achieved and to establish social institutions that spread and promote that lifestyle widely.

Economic systems and societies for human beings to continue to survive with the blessings of nature

Economic systems provide mankind with tools to become rich, but the unbridled pursuit of profit leads to the unlimited expansion of greed and competition and results in inequality and conflict among people. There were quite a few companies that put emphasis on short-term economic gains and ended up discharging pollutants into the water and the atmosphere causing pollution. Global warming is caused as a result of consuming fossil fuels beyond the threshold.

We have not counted the environmental cost, which is regarded as an "external diseconomy," in the cost of our business activities that include labor, materials, and other costs. As a result, we have damaged the natural environment and caused the global environmental problems. Since the latter half of the 20th century, a number of initiatives to prevent local environmental destruction began to be implemented, but to solve environmental problems on a global scale, we must establish further various social rules and mechanisms. The market economy is thought to work best in raising the affluence and vitality of our societies. But on the other hand, it is necessary to have laws and regimes that lead to building the framework for a market economy that will not diminish nature's resilience.

Corporate activities that put priority on making profit based on economic rationality and efficiency are one of the major factors that have caused the global environmental problems. From now on, however, corporations are required to have the power to propose new values and lifestyles and disseminate them through the society. Basing their actions on new and unconventional corporate philosophies, corporate significance of existence is there in providing products and services that meet the needs of the society, and by doing so, corporations can make great contributions in overcoming the crisis for the survival of mankind, and overcoming the global environmental problems.

In what direction do we need to move to create a society that will not damage nature's ability to recover? We must treat nature as the basis of life and deal with it to create a society according to the features of each region. The natural environment differs with the region, in each of which people have been leading their lives and nurturing their unique culture with the blessings of nature. To treat nature as the basis of life means to fully understand the inherent features of the natural world in your own locality and lead a life that does not damage the sound mechanisms of nature. To ensure this, it is necessary to create a society where both in urban and rural areas people come in contact with nature and enjoy its blessings. And in building such a society, local communities must be established that will gather the wisdom of their localities and expand their ties among the people.

(3) Dialogue and International Cooperation to Build a Network for a Global Society

The 20th century was characterized by market competition. That provided the driving force for the development of the economy and

the society but also triggered expanded competition in personal interest and greed. Global environmental problems are one of the results of such competition.

In the 21st century, with the limits in resources and the environment becoming clear, limitless pursuit of development and competition is no longer permissible, and it is becoming increasingly important to consider how to cooperate and collaborate to conserve and use limited resources and the environment. In other words, it is all the more important to conserve the resources and the environment through cooperation and collaboration among people with burden sharing rather than the kind of competition that had been prioritized. "Consideration for others" is thus becoming more important than "confrontation." Competition has created a self-centered mind that made people give priority to their own benefit and distrust their competitors, causing confrontation in their relationships. In order to restore trust among them, it is vital to rebuild social organizations so that people can communicate with each other competently. Communities such as families and local societies have changed a lot compared to the past, but they can still play an important coordinating role in environmental conservation as communities based on kinship or local habitation. Precious local resources, such as water resources, forests that provide richness in the area and the beautiful scenery could be utilized based on mutual trust within the local society.

On the other hand, problems that have to be dealt with on a global scale such as global environmental problems cannot be solved only by building relations of trust among those in close circles such as families and local communities, as there will be different levels of interests among countries and industries. At present, each country has its own sovereignty and if a country says "No" to an international treaty because it is not in its own national interest, other countries cannot force the country to sign the treaty. Reviewing the recent United Nations Framework Convention on Climate Change and the Kyoto Protocol, it is unfortunate to note each country insisting on its own national interest and to see that confrontations among countries are deepening. However, it is through dialogue that countries can start to understand each other's positions and ease confrontation so that they can seek possible solutions. Communication is actually being fostered, not only among countries, but also between countries and international organizations and NGOs. Dialogue is not to confront and defeat the logic of the opponent, but should work to recognize and understand the mutual relationship.

Countries should now cooperate for the benefit of the entire world, rather than insisting on their own national interests. All countries should regard themselves as members of the global society beyond national boundaries and make a concerted effort to solve our global environmental problems.

4 Establishing the "Blue Planet" and a Vibrant Society

In this document, the Round Table Conference proposes a vision of a new society: a "solar energy-based society," in which human beings can live vibrantly with the blessings of nature, and sends out the message that everyone has to play their role in restoring the "Blue Planet." Through dealing with global environmental problems, to realize a global society that can deal flexibly with the changes occurring to the Earth's system, which include both human beings and nature, the Round Table Conference is making suggestions on how future science and technology and the social systems should be. To make this a reality, let's not force individuals to act uniformly to attain a goal, and with the public value of the "Blue Planet" being realized, let us target a vibrant society where the originality and ingenuity of the individual are derived and utilized.

We sincerely hope that people firmly stand on the idea that human beings are a part of nature, and without being self-centered, think about nature, others, other countries and future generation, and by acting cooperatively with each other having "consideration for others," realise a global society which sets its foundation on dialogue and peace instead of confrontation and war.

Part 3

Messages from the Blue Planet Prize Laureates

Some of the Blue Planet Prize laureates, who are continuing to make great contributions to the solution of global environmental problems, have kindly sent us their messages in commemoration of the publication of *Conditions for Survival*. The proposals made by these insightful experts in their respective fields show us what we must do now for humankind and the Earth.

Building Public Support for The Environment

Prof. Jeffrey A. McNeely

2nd Blue Planet Prize laureate (1993)

Born in the United States in 1944, he graduated from the University of California at Los Angeles in 1967. He spent the next 12 years on research and practice in resources management in Thailand, Indonesia and Nepal. He joined the International Union for Conservation of Nature (IUCN) in 1977, was appointed Chief Scientist in 1995 and is currently Senior Science Advisor and Andrew D. White Professor-at-Large at Cornell University He is active in the field of conservation of nature as supervisory leader of the world's largest nature protection network.

Introduction

With more than half the world's population now living in cities, it often seems that people are losing touch with nature. Improving technology makes it far more convenient to stay at home and play video games than go outdoors to interact with the living environment. So what can be done to build public awareness about the importance of maintaining healthy ecosystems for all life on earth?

Many answers to this fundamental question are available, but I will here focus on only a few. Many economists think that the most effective way to build public support is through providing economic arguments for the value of the ecosystems that form our planet. After all, people are part of nature, and the diversity of elements, rocks, soils, species, and habitats has enabled life to flourish here. When people understand that ecosystems support the valuable processes that cleanse our air and water, pollinate our crops, decompose our waste, and control noxious pests and diseases, then they may begin to change the way they think about our planet.

For example, after the December 2004 tsunami hit the countries bordering the Andaman Sea, many observers noted that areas protected by mangrove forests suffered far less damage than areas where mangroves had been cleared to establish shrimp ponds. One result was renewed interest in maintaing existing mangroves and seeking to restore those that had been destroyed. Climate change which warms the sea surface of the western Pacific promises to bring more intense typhoons to coastal areas, including Japan, according to Kazuhisa Tsuboki of Nagoya University. This makes it even more important to conserve coastal vegetation as a barrier against storm surges from the sea.

When people realize that the water they drink, the food they eat, many of the fibers that cloth them, the fuels that keep them warm and cool, and the medicines that restore their health are produced by the intricate web of life, then they may well seek ways to become more active partners in conservation.

The economics of ecosystem services

Many of the benefits that people receive from nature – what often are called "ecosystem services" – have substantial economic values. As just one example, a recent study of the value of carbon sequestration in Canadian national parks found that replacing the carbon stored in these parks would cost between US$ 72 billion and US$ 78 billion. And the value of animal pollination services to the global economy is estimated at US$ 197 billion. A 2009 study by The Economics of Ecosystems and Biodiversity (TEEB) project reported that the value of ecosystem services in tropical forests averaged US$6,120 per hectare per year, far more than could be earned by timber alone. Coral reefs were found to be even more valuable, averaging US$115,704 per hectare per year. Many other such values of ecosystem services have also been calculated, with the total exceeding the annual gross national product of the planet. On economic grounds alone, a strong case can be made that ecosystems are well worth conserving.

But such arguments have not yet slowed the rate of environmental degradation at the global scale. So perhaps we first need to ask what changes human behavior, and find examples where people really have made a difference. This question of how to encourage human behavior that is in the public good has been addressed down through the ages, and many small-scale societies seem to have found ways to encourage their members to contribute

to sustainable societies, for example through taboos or strictly-enforced limits on harvesting. In Nepal, the Sherpa people who live on the slopes of Mt. Everest appoint their own forest guards, called shingo nawa, who are empowered by the community to limit the amount of firewood that can be harvested. The longevity of some societies indicates that sustainability is more than just a fond hope or a slogan from the United Nations.

Practical actions to build public support for the environment

But the emerging global community seems to be driven by an imperative to continue economic expansion despite signs that many natural resources and even entire ecosystems being over-exploited and degraded. Under these conditions, finding ways for individuals to influence powerful economic forces has been a constant challenge. But at least the following components have showed promise in some situations, and might be applied more broadly.

Ethics, the moral code by which people live. Religions that help to inform ethics have long tended to support respect for the environment. Already, the major religions are giving more support to environmental issues, especially climate change, drawing on the ancient teachings of the respective religions. At the species level, many cultures use animals as religious symbols. Such animals are often large and, at least potentially, dangerous. Snakes, for example, have symbolic values in Christianity, Hinduism, Buddhism, Judaism, and others. The naga is a mythological snake form probably based on the king cobra, and its influence is felt throughout south and southeast Asia, possibly linked to the monsoon rainfall that is so important for the rice-growing cultures that have provided the material basis for the civilizations in this part of the world. Large birds are also important spiritual symbols in many parts of the world and in many cultures, including the ancient Aztecs (Quetzal), and Egyptians (Horus), as well as modern Asian religions (Garuda). Large predators, such as jaguars, lions, bears, killer whales, and tigers, are also given spiritual value in many parts of their ranges. The power of such spiritual symbols is indicated by the geographical spread of respect for them, among many cultures. One modern application has been a programme launched in October 2008 called "Save Your Logo". Sponsored by the World Bank and the International Union for Conservation of Nature (IUCN), it sought to encourage private companies to invest in saving the species they used in their advertising, thereby helping them to maintain their image. And many countries have invested significant funding to save species of great national value, though with little commercial worth. The giant panda in China is an outstanding example.

Group self-interest. While many individuals may be interested primarily in their own benefit, many more may be motivated by helping their family, clan, or village. This sense of responsibility to the group is often extended, though perhaps somewhat weaker, to the national level, and even the global level (as in the case of concern about climate change). Perhaps once people have recognized that their behaviour in regard to the environment affects their own community, then they will behave more responsibly. In many parts of the world, mistreating animals is simply unacceptable social behaviour, and this feeling of identity with other species could be extended to entire

ecosystems as well. The key is to find ways that everyone can feel that he or she is making a contribution. One possibility in the field of climate change would be a carbon tax, so people who produce more greenhouse gas would pay more tax, thereby encouraging them to consume less and contribute to the public good. Consumer choices can also help the environment, for example by purchasing food that has been certified to have been produced in environmentally-friendly ways.

Peer pressure. What are other people doing, and what do they think about what you are doing? The growing popularity of electronic communication may be helpful here, building a social movement among young people in support of the environment. They may look up to popular singers, athletes, or artists, and if these individuals are seen through FaceBook or Twitter to be supporting environmental causes, then peer support may increase. More generally, research has shown that numerous contacts with neighbours, fellow students, or associates at work can contribute substantially to success, happiness, and health. Altruistic acts spread through social networks, so simply being kind to others is contagious. Using social networks to support the environment therefore has a sound basis in psychology and sociology. These networks can be even more effective if they are focused on outdoor activities. The popularity of hiking clubs, Scouts, birdwatching groups, and so forth has certainly helped to encourage governments to establish and manage protected areas where such activities can be carried out.

Building knowledge and information. The better the information that people have, the more likely they are going to respond appropriately to the environmental challenges that are sure to come. People are now inundated with information through multiple media, and when these support environmental causes, people may become more supportive. Environmental awareness should begin in early childhood, so cartoon programs popular as baby-sitters could include messages relevant to environmental issues, presented in an entertaining way. Environmental issues could be built into the entire school curriculum, not just in biology classes. Perhaps even better would be to enable people to contribute their own knowledge and information to conservation programmes. For example, gardeners could report the dates when buds or flowers first appear, thereby helping to document the impacts of climate change. Others may be interested in bird watching and recording the first migrants of the spring, again helping to link biodiversity with climate change. And as a general point, when people realize that biodiversity is essentially the way that ecosystems accumulate information, perhaps they will look at biodiversity conservation through new eyes.

Links to other issues. If "the environment" is seen as its own issue, perhaps the responsibility of a government agency or even a ministry, people may feel that the issues are being addressed, and that they have little to contribute. But as indicated earlier, maintaining healthy ecosystems is essential for human well-being, and relevant to all sectors of society, from agriculture to national security. While it may be important that some 12% of the Earth's land suface is under some sort of protected status, the other 88% is also important for the ecosystem services they provide. Demonstrating the impact of invasive species of fish

on Lake Biwa makes the issue come alive for people. The new "Satoyama Initiative" being planned as part of Japan's contribution to the 10th Conference of Parties to the Convention on Biological Diversity (to be held in Nagoya in October 2010) is another example, showing that traditional forms of agroforestry still have much relevance today. It is no great obstacle to discover what people really care about, and then build a link to healthy ecosystems.

Conclusions

Many people feel powerless in the face of the environmental challenges of the modern globalized world. Given the pervasiveness of climate change, loss of biodiversity, increasing pollution, and economic disruption, what can a mere individual do?

The answer is, quite a lot. Each individual can live as "greenly" as possible, seeking to minimize his or her ecological footprint to the maximum practical extent. Many people are already doing this. And remember that even a small behavioral change can set in motion changes in attitude or self-perception that over time will lead to larger changes, including in other people.

Second, all individuals can be as well informed as possible, and gather information in ways that are consistent with their own lifestyles. With the spread of electronic communication, people throughout the world now have access to more information than ever, so they have no excuse for not being well informed about the environmental issues that affect their lives. They can then participate in public debates about the issues, helping to build a strong public consensus for ecosystem health. But remember that environmental victories are often only temporary and subject to subsequent reconsideration, while destruction need take place only once for biodiversity to be lost forever.

Individuals can give their support to politicians who are sensitive to environmental concerns and will work in the public interest to ensure that policies at local, national and international level are supportive of a healthy environment. Some may even wish to run for local political office, and have a positive impact to their community and, ultimately, to the political party.

Individuals can join or otherwise support conservation organizations. Virtually every country has local conservation organizations, often numbering in the thousands. People can join local conservation organizations, larger ones at the national level, or even international ones, all working toward the common goal of a healthy environment for all people. At the local level, joining campaigns to save wetlands, re-direct roads that would have fragmented habitats, or conserve old-growth forests can be personally rewarding as well as environmentally productive.

While none of these steps by themselves will bring about huge changes, once people start behaving in an environmentally conscienscious way, the next steps become easier. And the more people support environmental causes, the more politicans are going to pay attention to the issues. Step by step, we can make progress on the long road toward the elusive goal of environmental sustainability.

Threatening curves, simple ideas, and a complex situation

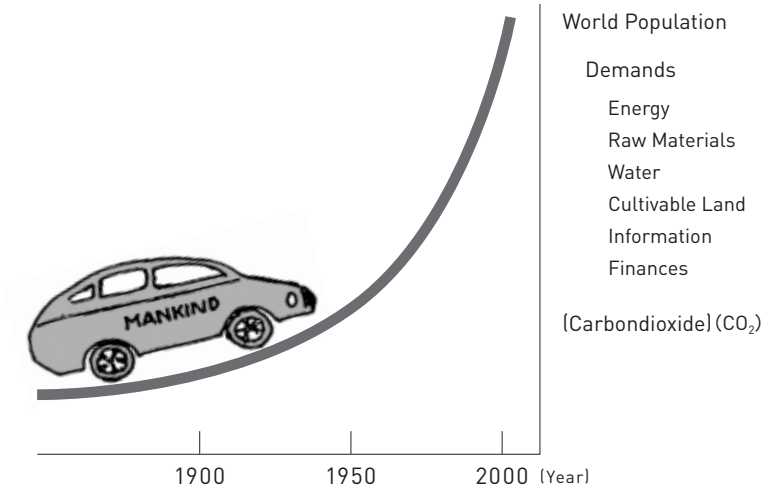
Prof. Dr. Eugen Seibold

3rd Blue Planet Prize laureate (1994)

Born in Germany in 1918, he earned his Ph.D. from the University of Tübingen in 1948. In 1958, he became full professor and director of the Geological-Palaeontological Institute at the University of Kiel. He was appointed president of the International Union of Geological Sciences (IUGS) in 1980 and became Honorary Professor at the University of Freiburg in 1986. He unraveled the formation process of carbonate accumulation in the ocean-sediments and made pioneering achievements in solving the problems in the global environment, including establishment of the foundation of CO_2 exchange between the atmosphere and ocean that has a major impact on global warming.

The situation mankind is in at present on our planet Earth is illustrated symbolically in figure 1. It shows the dangers we are facing: Mankind drives in a car through the centuries and is confronted with an increasingly steeper slope ahead (the sum of threatening curves). The world population was more or less stable until the industrial revolution some 250 years ago; there were about 1 billion people living on Earth. Since then, this population has grown dramatically, even exponentially: 1950 – 2.5 billion, 1970 – 3.7 billion, 1990 – 5.3 billion, 2000 – 6 billion people. Certainly from looking at Asahi's "Special Round Table Conference on Global Environment Problems" (2009) it seems that the annual population growth rate is diminishing: 2.5% in the 1970's, 2.2% in the 1980's, 1.9% in the 1990's, and l.6% reported

Fig. 1: Mankind and threatening curves



for 2005. However, this is not an "All Clear" signal, because there is still an annual increase of 80 million people. In addition, the demands of the world's population are growing. As one example, the consumption of primary energy (Tonnes of Oil Equivalent per person) increased from 1.36 in 1970 to 1.62 in 2005. As another example, there is the growing demand for more leisure time, or – in industrialized countries – for more two-car families, and so on.

All the data I have referred to are simplified. They are average, and industrialized and developing countries, North, South, East and West, have been mixed together. Some of these data are also based only on intelligent guesswork. The same is inevitably true for many of the "simple ideas" I will present in the rest of this essay.

Reality in a globalized world is inevitably complex, but one has to begin with problems individually.

I want to deal here with some threatening curves related to world population growth.

1) Petroleum

On human time scales, mineral resources are not increasing; it is obvious that they will eventually be used up, even when multiple-stage recycling is considered. Petroleum is mostly lost into the atmosphere by burning, that is to say by oxidation to carbon dioxide. This of course sharpens climate problems and contributes to another threatening curve – the increase of carbon dioxide in the atmosphere.

There are several methods by which the world's petroleum resources can be estimated. Being a geologist, I calculated already before the 1973 oil crisis that during the last 500 million years Nature had produced a few million barrels of oil every million years. Yet we now consume about 3 billion barrels annually! Exploitation like this is robbery. Geologists, geochemists, biologists and engineers are of course continuously improving secondary or tertiary recovery from existing oil fields. Higher prices also will force the expensive exploitation of tar sands and oil shales, but robbery goes on.

2) Coal

A similar situation exists for coal and lignite: both are lost to the atmosphere when they are burnt. Just as for petroleum, it would be preferable in the long run to use them more and more as an organic chemical resource to produce proteins or pharmaceuticals. Underground burning can also be employed to exploit even thin coal seams, Although up to now the relevant attempts have not been very promising. Coal can be used to produce gasoline and thereby to reduce gasoline-supply problems. This was already done in Germany during World War II, with the help of enormous government subsidies.

3) Natural gas

Natural gas, the purest of hydrocarbons, is of ever growing importance. During the last decades, the discovery of huge volumes of methane stored in methane hydrates has led to the hope of giant supplies of gas around all those continental margins where pressures and temperatures are favourable for methane hydrate formation and preservation. A yet-unsolved problem, however, is the economic exploitation of these deposits. The same is true also for deposits in areas of permafrost in polar regions.

4) Geothermal energy

The supply of energy is crucial for the survival of Western civilization and for the development of all countries. It is the basis for the functioning of agriculture, transport and industry. Geothermal

energy therefore should not be forgotten, even though it is only of importance regionally in volcanic areas like Iceland or parts of Japan. It can also be of local importance for houses or settlements.

5) Supplementary energy sources

At present and certainly for the next decades, the world's energy supply will come primarily from fossil sources (oil, gas and coal, together with uranium for – safe – nuclear reactors) and from water power – "white coal". Roughly 88 percent of the energy supply is based on fossil energy. Of course we have to increase the supply of energy from geothermal, solar and wind sources, from currents and waves of the sea and from renewable biological sources.

These sources will remain supplementary, however, for a long period to come.

6) Mineral resources

Mineral resources become depleted because they cannot be formed on human time scales. Volcanic sulfur may be an exception. Seen globally, there is no bottle-neck in the Supply of iron, aluminium, manganese. However, there may be problems in the supply of cobalt and nickel for special steels, in the supply of copper, and in the supply of some rare earths necessary for high-technology applications. Plant production is affected by the availability of fertilizers from phosphates and potash salts.

7) Water

The supply of water is not a global problem; it is a regional one that nevertheless is often dramatic. Modern industries need more and more water; private usage of water constantly grows; irrigation in agriculture (and even for golf course in many arid areas!) demands ever more; potable water in cities and towns becomes more and more precious. To supply fresh water to new settlements, rich countries even use a real energy-robbing approach: seawater desalination.

The recycling of water is made ever more difficult as the result of pollution by many inorganic and organic chemicals from various sources. This is again the cumulative effect of Population growth combined with more demands!

8) Cultivable land

The production of plants for food depends most obviously on soil quality and water. However, it depends primarily on the availability of cultivable land. For centuries, man has very ingeniously increased the amount of cultivable land, for instance by reclaiming land from marine tidal flats or by constructing terraces on steep slopes to cultivate rice, grapes or olives. At present, however, many of these terraces are falling into decay because of their maintenance costs. At the same time, huge areas of prime agricultural land are used up for highways, airports, parking lots and other commercial and industrial purposes. The production of gasoline from plants such as sugar cane, rape or cereals also has as a side-effect the reduction of the area of land available for food production. Possibly, the cultivation of microalgae in the sea will in the future become an important method to produce biofuel. Clearly there is an urgent need to increase crop yields, for example using molecular biology. This could result in higher quantities and qualities, in greater resistivity to parasites, in less damage from climate etc.

9) Information

At present, we are flooded with information and must always try to sort out those parts that are reliable. A special danger is the

growing general availability of private data. If it is in fact true that humans (in contrast to other animals) develop during their life their individual and unmistakable individuality, then privacy is a key feature of being human. The growing availability of private data is thus an inhuman trend – but who can and will stop it? Perhaps it is some small comfort to know that many types of data can no longer be read after a time, simply because of the rapidly changing technologies by which they are stored!

10) Finance and human resources

The growing importance of science and technology is illustrated by the growing number of people involved in these fields and by the increasing costs for laboratories and instruments. The costs of medical care are increasing similarly. All of this can conveniently be subsumed under the heading "human resources", an unfortunate term. Where natural resources are reduced, human resources can and must be increased. Human knowledge and education stimulate creative ideas to solve some of our threatening problems. One of the most threatening of these problems is the changing mental attitude towards money itself. Personal debts and credits are becoming overwhelming, and some bankers have lost all sense of proportion. The "anything goes" attitude has led to megalomania, with unknown consequences for the coming generations.

11) Climate Change

Many observations demonstrate that the world climate was and still is changing continuously. There are also strong indications that the actions of man have contributed to this change, at least since the Industrial Revolution. At present, global warming is the word of the day. Some of the trends mentioned earlier in this essay are directly influenced by this Warming.

The rise of global sea level due to higher ocean temperatures and melting glaciers threatens low island sand deltas dramatically. Even cliffed coasts will suffer as a result of increasing storm activity. Climate zones on land and their vegetation begin to shift. In some regions, extreme conditions such as droughts or floods are increasingly producing damage. Higher air temperatures are beginning to melt parts of the permafrost cement in high mountain areas, thus destabilizing slopes. In arctic areas higher air temperatures stimulate the escape of methane from permafrost and therefore cause additional warming. However, the amount and the speed of these changes are an ongoing matter of discussion.

12) Earth System Research

Man's landing on the moon in 1969 had two results that are relevant in this essay. The first was that man could now directly see our Earth as a sphere in space, as a limited unit on which we have to live. Thus the field known as "Earth System Research" was born. The elements of Earth System Research include conventional field measurement, controlled laboratory experiments, long-term satellite experiments, investigations in climate archives found in ice and sediment cores, and numerical modeling. All of this type of work has to do with many factors and is therefore extremely complicated and expensive. Forecasting is very difficult, and even the present state of the Earth is still not well enough known. But, before therapy, a physician has to make an exact diagnosis.

The second result of the Moon landing was the development of the conviction that "everything is now possible". Some scientists and engineers are already discussing therapies for the Earth – effectively taking a second step before the first one is over. Thus we

hear from these modern Jules Vernes that "Earth Management" has to ensure that global warming is kept below 2 degrees Centigrade, that "Synthetic Biology" can be used to repair genetic damage, and even that new primitive organisms can be created. And why not use other planets for additional mineral resources, Or even for settlements? All of these therapies are being discussed in spite of the fact that one billion people today are suffering from hunger and that another billion cannot even get clean water on this present "Best of all Worlds".

13) Some consequences

To cope with these challenges we need the help of creative scientists and engineers to save energy, to save water, and even to replace mineral resources. Research on nuclear fusion should continue. Plant production, both for food and for biofuel, must be increased, especially using molecular biological techniques. Ideas are needed for methods that can better deal with global information and financial issues. These ideas, however, will likely suffer from international competition. As Darwin demonstrated, competition is a fundamental feature of organisms; it is the motor for progress. The importance of competition was already officially acknowledged in ancient Greece, in the Olympic Games. However, in those Games the limits of performance were set by the human body. Today, competition in science, in economics, and in finance seems to have no inherent limits. And fairness may therefore suffer. By far the most difficult task mankind faces is to reduce the world's population; at the same time the global pool of scientific and engineering expertise needs to increase. Both of these changes have to be brought about by education. A reduction in the world's population of perhaps a billion is necessary; In contrast, the required increase in the number of scientists and engineers is perhaps some millions.

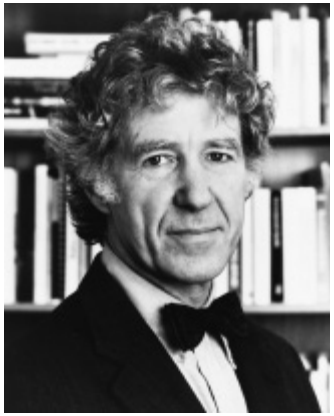
If we cannot stop the dreadful trends that threaten us, then the species Homo sapiens may even become extinct. This will not be a surprise to geologists. More than 99 % of all species of organisms have disappeared by natural causes during Earth's history, and species in general do not live for more than a couple of million years. Perhaps Homo sapiens will even contribute actively to his own extinction, e.g. by nuclear accidents.

Finally, in considering how to solve our common problems, it is necessary to bear in mind all the aspects of our human nature. Humans are not only creatures that possess the gift of reason; we have emotions too, and a feeling of transcendency – if only while listening to good music or reading good poetry. This is as true today as it ever was. We have to combine knowledge with wisdom. Sometimes, therefore, we should consciously remember the importance to us of terms like modesty and charity, and if trying to understand life, respect and humility too.

Facing the threatening curves evokes many reflections. I am convinced that most people will agree with these simple ideas I have put forward here, although some will regard them as too simple or too idealistic. Several of the consequences I foresee may look unrealistic. Nevertheless, many people would benefit greatly if our societies would take these ideas and these consequences seriously and would act appropriately. Hopefully, more and more people will apply them too in their private lives. Permanent education is needed to avoid the attitude expressed in the Norwegian saying: "Nobody does what everybody ought to do".

Acknowledgement: John Tipper kindly corrected the English text.

Could Food Shortages Bring Down Civilization?



Mr. Lester R. Brown

3rd Blue Planet Prize laureate (1994)

Born in the United States in 1934, he earned his Master of Science degree in agricultural economics in 1959 from the University of Maryland. He joined the US Department of Agriculture in 1959. In 1974, he founded the Worldwatch Institute, which specializes in analysis of global environment issues. Global data on the global environment issues was organized systematically and published annually as State of the World reports. In 2010, he established the Earth Policy Institute to lay the roadmap to create an environmentally sustainable economy. He is the author of Plan B.

In early 2008, Saudi Arabia announced that, after being self-sufficient in wheat for over 20 years, the non-replenishable aquifer it had been pumping for irrigation was largely depleted. In response, officials said they would reduce their wheat harvest by one eighth each year until production would cease entirely in 2016. The Saudis then plan to use their oil wealth to import virtually all the grain consumed by their Canada-sized population of nearly 30 million people.

The Saudis are unique in being so wholly dependent on irrigation. But other, far larger, grain producers such as India and China are facing irrigation water losses and could face grain production declines.

A World Bank study of India's water balance notes that 15 percent of its grain harvest is produced by overpumping. In human terms, 175 million Indians are being fed with grain produced from wells that will be going dry. The comparable number for China is 130 million. Among the many other countries facing harvest reductions from groundwater depletion are Pakistan, Iran, and Yemen.

The tripling of world wheat, rice, and corn prices between mid-2006 and mid-2008 signaled our growing vulnerability to food shortages. It took the worst economic meltdown since the Great Depression to lower grain prices.

Past decades have witnessed world grain price surges, but they were event-driven—a drought in the former Soviet Union, a monsoon failure in India, or a crop-withering heat wave in the U.S. Corn Belt. This most recent price surge was trend-driven, the result of our failure to reverse the environmental trends that are undermining world food production.

These trends include—in addition to falling water tables—eroding soils and rising temperatures from increasing greenhouse

gas emissions. Rising temperatures bring crop-shrinking heat waves, melting ice sheets, rising sea level, and shrinking mountain glaciers.

With both the Greenland and West Antarctic ice sheets melting at an accelerating pace, sea level could rise by up to six feet during this century. Such a rise would inundate much of the Mekong Delta, which produces half of the rice in Viet Nam, the world's second-ranking rice exporter. Even a three-foot rise in sea level would cover half the riceland in Bangladesh, a country of 160 million people. And these are only two of Asia's many rice-growing river deltas.

The world's mountain glaciers have shrunk for 18 consecutive years. Many smaller glaciers have disappeared. Nowhere is the melting more alarming than in the Himalayas and on the Tibetan plateau where the ice melt from glaciers sustains not only the dry-season flow of the Indus, Ganges, Yangtze, and Yellow rivers but also the irrigation systems that depend on them. Without these glaciers, many Asian rivers would cease to flow during the dry season.

The wheat and rice harvests of China and India would be directly affected. China is the world's leading wheat producer. India is second. (The United States is third.) With rice, China and India totally dominate the world harvest. The projected melting of these glaciers if we stay with business as usual poses the most massive threat to food security the world has ever faced.

The number of hungry people, which was declining for several decades, bottomed out in the mid-1990s at 825 million. It then climbed to 915 million in 2008 and jumped to over 1 billion in 2009. With world food prices projected to continue rising, so too will the number of hungry people, leaving millions of families trying to survive on one meal per day.

We know from studying earlier civilizations such as the Sumerians, Mayans, and many others, that more often than not it was food shortages that led to their demise. It now appears that food may be the weak link in our early twenty-first century civilization as well.

The world is entering a new food era, one marked by rising food prices, growing numbers of hungry people, and an emerging politics of food scarcity. As grain-exporting countries restrict or even ban exports to keep domestic food prices from spiraling out of control, importing countries are losing confidence in the market's ability to supply their needs. In response, the more affluent ones such as Saudi Arabia, China, and South Korea are leasing and buying large tracts of land in developing countries on which to grow food for themselves.

Among the countries in which large tracts of land are being acquired are Ethiopia and Sudan, both already heavily dependent on World Food Programme lifelines to stave off famine. In effect, the competition for land and water, in the form of land acquisitions, has crossed national boundaries, opening a new chapter in the history of food security.

Our early twenty-first century civilization is showing signs of stress as individual countries compete not only for scarce food but also for the land and water to produce it. People expect their governments to provide food security. Indeed, the inability to do so is one of the hallmarks of a failing state. Each year the list of failing states grows longer, leaving us with a disturbing question: How many failing states before our global civilization begins to unravel?

Will we follow in the footsteps of the Sumerians and the

Mayans or can we change course—and do it before time runs out? Can we move onto an economic path that is environmentally sustainable? We think we can. That is what Plan B is about.

Plan B aims to stabilize climate, stabilize population, eradicate poverty, and restore the economy's natural support systems. It prescribes a worldwide cut in net carbon emissions of 80 percent by 2020, thus keeping atmospheric CO_2 concentrations from exceeding 400 parts per million. In setting this goal, I did not ask what would be politically popular but rather what would it take to have a decent shot at saving the Greenland ice sheet and at least the larger glaciers in the mountains of Asia.

Cutting carbon emissions will require both a worldwide revolution in energy efficiency and a shift from oil, coal, and gas to wind, solar, and geothermal energy. The energy efficiency revolution will transform everything from lighting to transportation. With lighting, for example, shifting from incandescents to compact fluorescent bulbs can reduce electricity use for lighting by 75 percent. But shifting from incandescents to the newer light-emitting diodes (LEDs) combined with light sensors can cut electricity use by more than 90 percent.

At least one of the new plug-in gas electric hybrids coming to market can get over 200 miles per gallon of gasoline. In the Plan B energy economy of 2020, most of the fleet will be plug-in hybrids and all-electric cars, and they will be running largely on wind-generated electricity for the gasoline equivalent of less than $1 per gallon.

The shift to renewable sources of energy is moving at a pace and on a scale we could not imagine even two years ago. Consider the state of Texas. The enormous number of wind projects under development, on top of the 9,000 megawatts of wind generating capacity in operation and under construction, will bring Texas to over 50,000 megawatts of wind generating capacity (think 50 coal-fired power plants) when all these wind farms are completed. This will more than satisfy the needs of the state's 24 million residents.

Nationwide, new wind generating capacity in 2008 totaled 8,400 megawatts while new coal plants totaled only 1,400 megawatts. The annual growth in solar generating capacity will also soon overtake that of coal. The energy transition is under way.

The United States has led the world in each of the last four years in new wind generating capacity, having overtaken Germany in 2005. But this lead will be short-lived as China appears set to blow by the United States in new wind capacity added in 2009.

China, with its Wind Base program, is working on six wind farm mega-complexes with generating capacities that range from 10,000 to 30,000 megawatts, for a total of 105,000 megawatts. This is in addition to the hundreds of smaller wind farms built or planned.

Wind is not the only option. In July 2009, a consortium of European corporations led by Munich Re, and including Deutsche Bank, Siemens, and ABB plus an Algerian firm, announced a proposal to tap the massive solar thermal generating capacity in North Africa and the eastern Mediterranean. A German firm calculates that solar thermal power plants in North Africa could economically supply half of Europe's electricity. Algeria, which has already completed its first solar thermal plant, has signed an agreement to supply Germany with solar-generated electricity. The Algerians note that they have enough harnessable solar energy in their desert to power the world economy. (No, this is not an error.)

The soaring investment in wind, solar, and geothermal energy is being driven by the exciting realization that these renewables can last as long as the earth itself. In contrast to investing in new oil

fields where well yields begin to decline in a matter of decades, or in coal mines where the seams run out, these new energy sources can last forever.

The combination of efficiency advances, the wholesale shift to renewable energy, and expansion of the earth's tree cover outlined in Plan B would allow the world to cut net global carbon emissions 80 percent by 2020. In contrast to today's global electricity sector, where coal supplies 40 percent of electricity, Plan B sees wind emerging as the centerpiece in the 2020 energy economy, supplying 40 percent of all electricity.

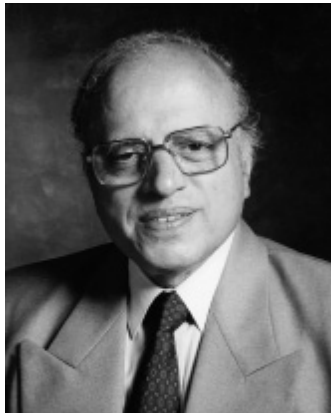
We are in a race between political tipping points and natural tipping points. Can we cut carbon emissions fast enough to save the Greenland ice sheet and avoid the resulting rise in sea level? Can we close coal-fired power plants fast enough to save at least the larger glaciers in the Himalayas and on the Tibetan Plateau? Can we stabilize population by lowering fertility before nature takes over and halts population growth by raising mortality?

Yes. But it will take something close to a wartime mobilization, one similar to that of the United States in 1942 as it restructured its industrial economy in a matter of months. We used to talk about saving the planet, but it is civilization itself that is now at risk.

Saving civilization is not a spectator sport. Each of us must push for rapid change. And we must be armed with a plan outlining the changes needed.

It is decision time. Like earlier civilizations that got into environmental trouble, we have to make a choice. We can stay with business as usual and watch our economy decline and our civilization unravel, or we can adopt Plan B and be the generation that mobilizes to save civilization. Our generation will make the decision, but it will affect life on earth for all generations to come.

Achieving Food for All and Forever



Dr. M. S. Swaminathan

5th Blue Planet Prize laureate (1996)

Born in India in 1925, he earned his Ph.D. from the University of Cambridge in 1952. He is regarded the leader of the "Green Revolution" movement for his contribution to the restoration of Indian agriculture. A proponent of sustainable agriculture that leads to a permanent Green Revolution, he is a leader in sustainable food security and is regarded one of the 20 most influential Asians of the 20th century. He founded MS Swaminathan Research Foundation in 1988 and serves as its chairman to date.

Introduction

Following the domestication of plants over 10,000 year ago leading to the birth of agriculture or settled cultivation, there was considerable emphasis on the sustainability of productivity. The immediate problems were two fold. First, there was a diminishing return from the soil leading to a gradual decline in yield. Therefore, it became important to develop methods by which the nutrients taken from the soil can be restored to it. The answer of the early farmers to this challenge was the introduction of shifting cultivation, which means abandoning the land for a few years after cropping for some years. Even today in the northeast of India, the practice of *jhumming* or shifting cultivation is still prevalent. However, the early cultivators practiced sustainable shifting cultivation in the sense that the land which was earlier under the plough was allowed to regenerate over many years before being put back under the plough. Unfortunately now the *jhum* cycle has become very short and there is no time for the earlier cultivated land to regenerate fully. Another method adopted for soil fertility restoration was the introduction of cereal – legume rotation on the one hand, and crop-livestock integrated farming on the other. The practice of ploughing back into the soil all agricultural residues was also adopted to improve the physical structure of the soil as well as the soil organic matter. Thus, a sustainable system of soil health maintenance and enhancement was standardized through experience and experiment.

Another major problem faced by the early practitioners of settled agriculture was the incidence of pests and diseases. Crop health management became a major challenge. The response to this challenge was in the form of maintenance of agro-biodiversity, selection of resistant varieties, use of botanical pesticides and inter-cropping and multiple cropping. These all help to insulate agriculture from severe loss as a result of pest epidemics. In the temperate region, snow and extreme cold weather interrupt the pest cycle, but in the tropics crops are grown all round the year and there are alternative hosts for many major pests. This is why the pest load is very heavy in tropical agriculture. In the past, the multiple and intercropping systems adopted were designed to interrupt the pest breeding cycle. Crop mixtures and rotations perform in the tropics the same role as extreme weather conditions do in the temperate region in terms of pest build-up preventions.

In addition to the development and adoption of agronomic practices, which will help to maintain and enhance soil health and prevent pest epidemics, the early generation of farmers also practiced water-harvesting procedures. Thus, tanks were always associated with temples and religious institutions. Water harvesting and community sharing became part of the spiritual and cultural heritage. Similarly biodiversity conservation was practiced both through *in situ* on-farm conservation and *ex situ* Sacred Groves. Temple trees were chosen on the basis of their ecological significance. For example, the Temple Tree in the Lord Nataraja Temple in Chidambaram, Tamil Nadu, is a mangrove species, *Exocaria agallocha*. This is because of the knowledge that mangroves serve as bioshields during coastal storms.

Many of these traditional practices of natural resources conservation and sustainable use gradually gave way to the unsustainable exploitation of land, water, forest and biodiversity. Cereal – legume crop rotations gave way to monoculture. While on the one hand the green revolution, which marked the beginning of expansion of production through productivity improvement, became a blessing in terms of saving land and forests, on the other,

it led to problems of land and water mining and environmental pollution arising from the excessive use of chemical pesticides and mineral fertilizers. The kinds of problems that exploitative agriculture can create were described by me at the Indian Science Congress held in Varanasi in January 1968 in the following words:
"Exploitive agriculture offers great dangers if carried out with only an immediate profit or production motive. The emerging exploitive farming community in India should become aware of this. Intensive cultivation of land without conservation of soil fertility and soil structure would lead, ultimately, to the springing up of deserts. Irrigation without arrangements for drainage would result in soils getting alkaline or saline. Indiscriminate use of pesticides, fungicides and herbicides could cause adverse changes in biological balance as well as lead to an increase in the incidence of cancer and other diseases, through the toxic residues present in the grains or other edible parts. Unscientific tapping of underground water will lead to the rapid exhaustion of this wonderful capital resource left to us through ages of natural farming. The rapid replacement of numerous locally adapted varieties with one or two high-yielding strains in large contiguous areas would result in the spread of serious diseases capable of wiping out entire crops, as happened prior to the Irish potato famine of 1854 and the Bengal rice famine in 1942. Therefore the initiation of exploitive agriculture without a proper understanding of the various consequences of every one of the changes introduced into traditional agriculture, and without first building up a proper scientific and training base to sustain it, may only lead us, in the long run, into an era of agricultural disaster rather than one of agricultural prosperity."

From the above, it will be clear that sustainability science is a multi-disciplinary field. It requires a holistic approach while analyzing problems like what I did in my analysis of high yield agriculture in 1968, before the term green revolution was coined by Mr William Gaud of USA in September 1968. Such an inter-disciplinary science has to be built on the following foundations.

Ethics

Ethical considerations will have to guide human behaviour in relation to natural resources exploitation. Bioethics and environmental ethics are now developing into well-defined scientific areas. The ethical responsibility of safeguarding the environment rests on professionals, political leaders and the public. In the past by investing conservation with spiritual significance, every individual was made to integrate ethics in day to day life.

Economics

Ecological economics does not permit depreciation of natural assets. Thus it has a time dimension of infinity. Ecological economics is also a fast developing science and it will help to measure the benefit – risk structure of development projects from the point of view of their long-term impact. Ecological economics should become part of the curriculum in technological and management institutions. All dependants on natural resources for their enterprises should understand that good ecology is the pathway to good and enduring business.

Equity

The concept of equity is now discussed in terms of both intra-generational equity and inter-generational equity (i.e. safeguarding

the interests of the future generations). For example, over-exploitation and pollution of the aquifer will deny opportunities for ground water availability to future generations. Similarly, the melting of ice and glaciers resulting in water shortage in cold desert areas like Ladakh will force the future generations to migrate from the area. Climate change leading to the melting of ice will not only cause floods in the plains but also a rise in sea level over a period of time. Another important component of equity relates to the gender dimension of sustainability science. Women are the great conservers of biodiversity and natural resources. Their role should be acknowledged and strengthened.

Energy

Energy is a key factor in terms of both economic development and climate change. Integrated energy supply systems involving the optimum use of all renewable forms of energy like solar, wind, biomass, biogas, geothermal etc., have to be developed. Other opportunities like hydrogen and nuclear energy will have to be integrated into an overall sustainable energy security system.

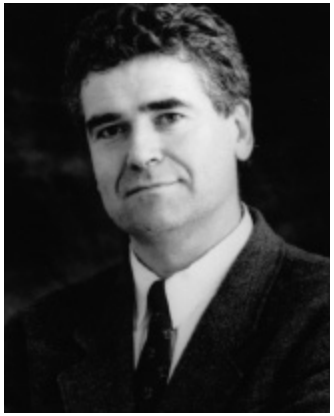
Employment

Many of the livelihood opportunities in developing countries are based on the use of natural resources like land, water, forest and biodiversity. Emerging technologies tend to promote jobless economic growth. In population rich but land and water hungry countries, there is need for job-led economic growth. Therefore development experts and technology developers should take into account the impact of new technologies and management procedures on job and livelihood security. Jobless growth is joyless growth in population rich countries.

Education

Education is a cross cutting theme and has to take into account all the above-mentioned factors. Environmental literacy should be based on the principle of "do ecology". For example, in the case of biodiversity, there is need to create an economic stake in conservation. Orphan crops can be saved only if there are markets for them. Similarly in the case of nature tourism, those who operate houseboats or hotels in eco-sensitive areas should be aware that good ecology is good business. Environmental education should also be based on practical examples, which can drive home the message, which is to be conveyed. Therefore, it should be based on field projects which can demonstrate how to organize ecotourism, conduct green audit, manage rain forests sustainably, etc. Just as action research programmes help to gather data on the economics and ecology of development projects, action education will derive its roots from field experience.

Crisis in leadership around Sustainable Development



Dr. Karl-Henrik Robèrt

9th Blue Planet Prize laureate (2000)

Born in Sweden in 1947 and earned his Ph.D. in medicine in 1979 at the Karolinksa Institute. He founded The Natural Step in 1989. He became Professor of Resource Theory at University of Gothenburg in 1995. At present, he is professor of sustainability at Blekinge Institute of Technology and at the same time chairman of the international research program Real Change pursuing a unifying framework for sustainable development.

Choices between evils. As our leaders in policy and business seek solutions to sustainability related problems, they often find themselves making choices between evils. How those choices make sense, or not, as stepping stones towards a sustainable society, is missing more or less completely in the debate. This is because our leaders don't know what sustainability is. They simply don't have an operational definition. And that is today's most serious sustainability problem, not climate, pollution, declining biodiversity, freshwater scarcity, poverty, nuclear threats or terrorism. The lack of a shared understanding of what sustainability really means is the major impediment to progress on sustainable development. More and more leaders have begun to understand this, but they still often reach the wrong conclusions.

Leadership puts demands on competence, not only values. It is the main task of leaders, not experts, to define goals on an overriding societal level, and to keep sectors and departments coordinated along the way. On this, i.e. policy guidance and leadership, experts are mostly amateurs. But today's sustainability decisions in policy and business are often developed in various summits and commissions where responsibilities are transferred from leaders to experts. The result is attempts to build decisions *directly* from an understanding of some parts of systems e.g. "ecosystems" or "climate" or "agriculture", but still without an understanding of the connections between those parts at the level of the full system. It becomes impossible to evaluate impacts against desired outcomes in any comprehensive or meaningful way without a view of full system consequences. The result is talk clubs, comparing evils. Or worse, policy makers seeking scientific support for proposals they have already decided to make. Efforts

to move directly from scientific facts to decision making are called "the naturalistic fallacy". Meanwhile damage is increasing in social and ecological systems, faith in our leaders declines, young people's expectations about the future are low, and finance and economic crises become inevitable.

A few examples

Within the fuel sector, renewable fuel production from biomass, e.g. corn in the US, is allowed to compete with food production. This has lead to negative consequences, e.g. in the social system through escalating food prices. Furthermore, the smart ways by which fuels from biomass can be produced (so as to link naturally to the future's much more efficient energy- and fuel- and agricultural systems), is hardly discussed at all. And the result is a bad reputation for all fuel-alcohols.

Another example is the debate on "ecological farming" vs. "industrial farming". In fact, both options have their respective advantages and disadvantages. They are currently compared with each other, without any reference made to the huge challenge of moving systematically towards sustainability for the whole sector. From a future perspective, none of the current alternatives will suffice if we are to avoid much worse starvation catastrophes than the ones we have already seen. "Industrial" as well as "ecological" agriculture ought to develop stepwise towards sustainability in a way that they could learn from each other. This requires another type of more cooperative and systematic scientific dialogue than the debate currently going on at the global level.

Yet another example is nuclear power. It is proposed by many as the solution to climate change. Opponents, on the other hand, point at all the serious problems such as inevitable accidents, linkage to nuclear arms, radioactive pollution from leakages, waste management, and vulnerable centralization of energy solutions. The choice seems to be between global warming and nuclear winter. In this debate, it is rare that the participants are requested to explain how developments within any of those energy alternatives could serve as stepping stones, in a way that is financially competitive, towards completely sustainable energy systems. Renewable energy also continues to be discussed in a non-strategic way. The accessibility of sustainable energy sources (direct and indirect sun, geothermal, and tidal waters) is many times larger than our needs will ever be. The costs for the fuel cycle are relatively low or zero for those systems, and they don't inherently build on accumulation of dangerous waste and other risks. Yet sustainable energy is often discussed in terms of naïve dreams. "Those systems can not be applied until they are developed". It is like saying: "I will not begin exercising until I am fit".

Strategic planning towards sustainability can be taught.

"Why." It is a myth that "a policy that supports sustainability is bad for competition in business". Historic, theoretic and empiric research shows that it is the other way around. The problem is, again, that our leaders in policy and business don't know what sustainability is. So they do not see how large a proportion of today's financial crisis is in fact related to un-sustainable decisions made in the past, nor how many problems have been avoided by those organizations that have acquired the knowledge. The

latter are still in minority, e.g. US based Interface calling full sustainability "The Top of Mount Sustainability", or Nike Calling it "North Star", or Rohm & Haas (now Dow Chemical Company) and Whistler, the next host for the winter Olympics, simply calling it "TNS System Conditions".

"What." For the individual decision maker, it is enough to respond to three simple questions to decide whereas his or her organization needs to acquire the competence: (1) Do you have a definition of social and ecological sustainability? (2) If so, what is your current gap to full sustainability? (3) What are you doing, at the strategic level, to bridge the gap? If you put all questions together, there is generally no answer. If you cannot reply to the first question, you cannot respond to the other two. If you don't have an operational definition of where you are going, the rest doesn't matter – you are not a leader.

"How." For strategic planning, there are today well developed methods that are relatively easy to learn and practice. They support powerful decision making and leadership. Over a twenty year period, a unifying framework for sustainable development has been developed, practiced, and refined to respond to the leadership challenge presented in this essay. It is known as the Framework for Strategic Sustainable Development, FSSD, or "The Natural Step Framework" from the NGO that has facilitated its scientific exploration and applies it for advice in business and policy around the world. It is now also part of a 10-year research program, Real Change, involving universities, business corporations, municipalities and governmental authorities across the globe. It goes beyond the scope of this essay to teach the Framework.

Furthermore, the aim is not to "sell" the work that has been done up to this point. On the contrary, the aim is to present a logical flow of thoughts that lead up to the need for the framework with its unique qualities, to enable the recruiting of more scientists and decision makers into the ongoing Real Change learning dialogue:

- *Definition needed.* Sustainability will not happen outside the context of a robust definition of sustainability – trial and error and various piecemeal attempts will not take us there in time
- *Definition based on principles.* Social and ecological sustainability can only be defined at the level of principle. It cannot be defined at the level of detail. Sustainability will inherently appear in many different shapes depending on differences in conditions for different regions and organizations. Furthermore, technical and cultural development will keep changing conditions. What appears, for instance, to be an efficient way of sustainable energy today may seem hopelessly inefficient tomorrow. To lock on relatively specific targets too early in strategic approaches, is a mediocre way of strategic planning. The too-early focus upon detailed answers, means we carry today's preoccupations, problems and prejudices into the future, failing again to see the bigger picture and the full horizon of sustainability.
- *Strategic approach.* We need a systematic step-by-step approach towards a robust, principled, definition of social and ecological sustainability while ensuring a sufficient financial, ecological and social influx of resources on the way so as to sustain the process. This calls for a unifying framework for appropriate analyses of practices, analyses of visions and solutions, guidelines for development of strategic plans and

for more appropriate selection and use of tools and concepts.

- *Requirements of sustainability principles.* For basic principles of social and ecological sustainability to be operative, they need to have the following characteristics:
  - They must be necessary for sustainability (to avoid unnecessary restrictions)
  - They must be enough for sustainability (to avoid gaps in the thinking, and to allow elaboration into second and higher orders of principles so as to cover all aspects that are relevant for sustainability)
  - They must be general (for interdisciplinary and cross-sector cooperation to occur)
  - They must be concrete and applicable as criteria for re-design (so as to allow the step-by-step approach in real life planning).
  - They must not overlap, but be mutually exclusive (so as to allow comprehension and monitoring of approaches).
- *Unique deliverables from such a framework.* A generic framework developed in line with those considerations could deliver on the following:
  - Planning and modelling could occur from a perspective of the full potential of the system, based in physics and ecology, rather than being based on the constraints of current technologies and cultures.
  - Trade-offs between different investment alternatives could be dealt with in a logical way, evaluated as stepping stones towards sustainability rather than as choices between evils in the short time perspective.
  - It would make better use of existing tools and concepts for sustainable development, by selecting and informing the ones needed, and developing the ones lacking.
  - The problem of "system boundaries" can be solved. Though traditional science puts demands on clear system boundaries when systems are studied, we know upfront that there are no relevant system boundaries for sustainability. A "sustainable Tokyo" is impossible outside the context of world sustainability, and the same is true for "sustainable energy" if other sectors are not sustainable as well. Everything that needs to be taken into account for sustainability should be taken into account.
    Multidimensional planning in complex systems can have no other relevant system boundaries than purpose. Everything in society within the biosphere that is essential for sustainability in the context of a certain project or organization, regardless if it is measured in km/hour, mg/ml, annual harvest or any other dimension needs to be taken into account. Modern systems science helps us do this.
  - It would serve as a shared mental model for interdisciplinary and cross-cultural cooperation, and move those terms from buzz-words to reality.

Experiences made in the Real Change programme. Over 20 years, much of this work has been facilitated by the NGO The Natural Step. Now the recently launched Real Change Research Programme – a 10-year research program involving universities, business organizations, local governments and governmental authorities across the globe allows us to more systematically scrutinize and test the experiences made. This program is growing pretty much under the radar of main stream Industrial Ecology, but is currently reaching growing interest academically and in

practice. In concrete terms, we have case-studies from a number of universities in cooperation with organizations - business and municipalities. These are currently putting full sustainability on the table (defined, as far as we are able with current knowledge, all the way down to the basic principle level) after which strategic routes to comply with those principles are outlined. The outcome is a new type of action-research where tools, concepts, modeling and simulation emerge from system boundaries set by a robust definition of purpose (rather than as attempts to deal with impacts as those surface, one by one). As the framework is applied, it is continuously scrutinized and improved in learning dialogues between academia and practitioners.

It is a fantastic human experience to understand basic principles for worthy goals together, across disciplinary and professional and ideological boundaries, and realize that we need each other to reach the goal. Against that background, it is breathtaking that so few of our leaders know how to put full sustainability on the table, and to shape their debates and action programs accordingly. It is as if we should all be content with the idea of civilization succumbing a bit slower, if we only listen to this or that proposal. Strategic planning towards sustainability is not something that "comes to you" if you are only enough engaged in the public debate, have a certain field of expertise, or admit to a certain ideology. What we need today are decision makers that are prepared to sit on the school bench for a while, to achieve this competence and the language that comes with it. Only then can they make relevance of their leadership, cooperate efficiently across discipline- and sector boundaries, and only then can they ask the relevant questions of the experts.

Mankaind and The Environment

Dr. Norman Myers

10th Blue Planet Prize laureate (2001)

Born in the United Kingdom in 1934 and graduated from Oxford University in 1958. He earned his Ph.D. in 1973 from the University of California at Berkeley. Presently, he is a Fellow of the 21st Century School, Green College and the Said Business School, Oxford University and has been active as writer, photographer and lecturer on African wildlife. He issued the first warnings on mass extinction of species and tropical deforestation. In the 1980s, he introduced the concept of biodiversity hotspots and was a major influence on subsequent conservation activities.

"Never doubt that a small group of thoughtful committed citizens can change the world. Indeed it is the only thing that ever has."

———The American visionary Margaret Mead.

Our Earth and our world are in serious trouble, as has been demonstrated year after year by the Foundation's environmental surveys. Many people are aware of this crisis, many are not. Many people want to help create sustainable habitats, many (seemingly) don't care. How to make everyone aware of what is going on and encourage them to join in a great global campaign to confront the many dangers that beset us? These key questions form the focus of this essay.

GNP as an economic measure

A government's prime measure of its economy's health is Gross National Product (GNP), being a measure that supposedly supplies us with a realistic assessment of our economies. It is also vital to the business world, the media, and public opinion generally. Yet our quirky modes of calculating GNP mean that many economic losses are actually viewed as pluses since they entail economic transactions in the marketplace, and hence, willy-nilly, they are to be added on to GNP. In 2004, crime levied costs to the US economy totalling $34 billion, road injuries and deaths $175 billion, and pollution $199 billion. These, plus a good many other such "bads" totalling $6.4 trillion (equivalent to just over half of the official GNP) were added to, rather than subtracted from, GNP. On the plus side a host of "goods" totalling $4.4 trillion remain outside the GNP metric and include housework, child care and volunteer work. Even when adding these "goods" to GNP, we still find that a "Genuine Progress Indicator" (GPI) reveals a huge gap between GNP and GPI. In other words, Americans were not nearly so well off as they seemed to assume. In per-capita terms, during the period 1978-2004 the GPI did no better than remain constant at around $15,000.

There are other innovative modes of measuring economies, apart from the GPI, including 'Green' Accounting, Net National Product and an Index of Sustainable Economic Welfare (ISEW). These measures go far to recognizing that our economies are ultimately dependent on the environmental resource base that underpins all human activity. Within a few years there could well be several dozen front-rank countries managing their environmental wealth in the same way they currently manage their finances.

A further way to assess how a country is faring, and especially how far it is pursuing a sustainable path, is to invoke the Ecological Footprint, a mode of analysis examining our use, or over-use, of environmental resources such as water, soil, land and vegetation--these resources being collectively known as "biocapacity". Earth's 14 billion global hectares (gha) of biocapacity equates to only 2.1 gha per person, yet our average per-person footprint already exceeds 2.7 gha (Americans' 9.4 gha, Japanese 4.9 gha). The analysis further shows that we have increased our loading of the planet from 70% to 130% in just four decades. Or: our footprints amount to 1.2 "planets", and by 2030 they could expand to two planets. To achieve sustainable development, we need to get our footprints back below 2 gha. The Ecological Footprint concept is now a part of Japan's Basic Environmental Plan.

"Perverse" subsidies

Now for a look at how conventional economics is subject to

sizeable lacunae that are not as prominent as other problems but are highly significant nonetheless. Consider the propensity of governments to misuse fiscal instruments. Such instruments, whatever their form, should be designed to promote good policies and discourage bad ones. Instead, almost every government has created, almost without realizing it, a complex structure of subsidies which, once established, prove almost irremovable.

Certain subsides are harmful to our economies as well as our environments. Subsidies for agriculture foster over-loading of croplands, leading to erosion of topsoil, pollution from synthetic fertilizers and pesticides, and release of greenhouse gases. Subsidies for fossil fuels are a prime source of pollution. Subsidies for road transport also promote pollution, plus such other ills as road congestion. Subsidies for water encourage misuse and over-use of supplies. Subsidies for forestry encourage over-logging and other forms of deforestation. Subsidies for fisheries foster over-exploitation of fish stocks. Well might we term them "perverse." Such subsidies bedevil all our economies, whereupon the public interest, which was their original justification, becomes lost. They total $2 trillion a year worldwide—one quarter of them in the United States. As a measure of how far they damage the sustainability cause, note that in several economic sectors the subsidies inadvertently deplete biodiversity habitats through subsidies totalling at least $200 billion per year—a sum that contrasts with worldwide spending on conservation of biodiversity, $20 billion at most. This is all the more regrettable in that ecosystem services (pollination, soil formation, clean water, etc.,) are estimated to be worth a sum on a par with the global economy.

There is scarcely a sector of government that is in greater need of root-and-branch reform than subsidies—and it is precisely the long-run impact of subsidies on political processes that makes them so hard to change. If we could sort out just these two supersize roadblocks, viz. distortive GNP and perverse subsidies, our economies would leap ahead and in much more productive and sustainable fashion.

Population: deep denial

Ask anyone about the world's foremost environmental problems, and they will probably cite climate change, tropical deforestation, widespread pollution, energy shortages, water deficits, and so on. They are little likely to utter a word about population. The issue seems to have slipped off everyone's radar screen, especially politicians'.

Thus population has become the Great Unmentionable, even though population growth is implicated, whether directly or indirectly, in virtually all our problems. We know virtually all we need to do, viz. promote family planning and foster women's roles. We have stacks of success stories to hearten us on our way; Bangladesh, Egypt and Thailand have found that the benefits of preventing one unwanted birth exceed the costs in social services 10-16 times over; in certain Latin American countries every $1 spent on contraception saves up to $12 in health and education services alone. Regrettably we encounter a lengthy list of roadblocks: ignorance about the issue; sheer prejudice; and even subsidies for families beyond two children.

Fortunately there is a potentially upbeat side to population. No fewer than 140 million couples in developing countries lack the contraceptive means to put their family-planning wishes into action; another 64 million lack modern methods of contraception. If we were to meet these "unmet needs", we would reduce the ultimate

global total by well over one billion people. It costs an average of only $20 to meet these needs for one couple for one year, so we are talking about $2.8 billion in all. This sum is equivalent to well under one day's military spending worldwide, and we might well ask which outlay would purchase the greater security. For a rich-world taxpayer it would work out to no more than the cost of one hamburger supper. Is this not another instance where public opinion is way ahead of what our political leaders tell us.

Finally, let us remember that lack of contraception is not confined to developing countries. Of the six million pregnancies of American women each year, almost three million are unintended; result, 1.4 million unplanned births and 1.3 million abortions. How long until the United States can call itself a truly developed country? Each year the United States grows by just over 3 million people (including immigration), and the country's land mass is growing no bigger.

Overview

The above is not to ignore our many success stories. Without them we would be in far worse shape. But: is the remedy a simple case of "The same as before, only more so", or do we need to consider altogether new strategies as well? The author proposes that we should engage in an emphatic expansion of our policy purview. Could it be that most of our best efforts are merely reactive in nature, and hence we should do more to get ahead of the game—to tackle problems before they become problems?

Could it be, in fact, that the core problem does not lie so much with individuals who are ignorant or selfish or indifferent. Rather it lies with our ***institutions***, or the ways that society has devised to run our affairs—"the rules of the game." While many institutions serve us well, a good number lead us sorely astray (see, for notable example, the section on GNP above). Thus institutions reflect the collective needs of individual persons; and hence institutions made up of just a few like-minded individuals can shape the behaviour of far larger groups of citizens. To cite Edward Burke: *"Nobody ever made a greater mistake than he who did nothing because he could only do a little."* And reader, if you are still sceptical about how much of a difference can be made by an individual, you've never been in bed with a mosquito.

Non-governmental organizations (NGOs)

Perhaps the main way to foster cultural contagion is via NGOs. At the Stockholm Conference on the Human Environment in 1972, there were so few NGOs that they could have fitted into a single room. At the World Summit on Sustainable Development in 2002, there were several thousand NGOs—and they enjoyed a place as of right at the negotiating table, making for a dramatic increase in the potential of individual citizens to be agents of advance. More than half the world's people now live in democracies. Plus, the spread of information technology has empowered individuals to make common cause at a speed and on a scale previously unprecedented.

NGOs worldwide now comprise over one million organizations populated by over 100 million people. To cite the networking guru Paul Hawken, *"Collectively it constitutes the single biggest movement in the world. It doesn't know it is a movement, it has no name, yet it acts in aggregate because at its core it is based on shared values that are universal. It is an extraordinary source of new thinking, ideas and initiatives. The healing of the world is a massive challenge that can be undertaken only by ordinary citizens everywhere, not by governments or oligarchies somewhere."*

As an indication of NGOs' growing clout, in December 1997, 122 countries agreed to stop using and selling landmines. This remarkable breakthrough was attributed not so much to governments as to more than 1000 NGOs which had lobbied officials on the issue for years. This event marked a shift in the balance of power in international politics, unimaginable thirteen years ago.

There has been no other time, not remotely, when we could say that thanks to NGOs and the communications revolution, everybody can be somebody and nobody need be nobody. Every last citizen can make their voice heard in a global village that becomes ever-more populous and ever-more connected. By 2008 there were 1.4 billion Internet users 3.5 billion cell phones (one for every two persons on the planet). In 1993 there were only 50 sites on the World Wide Web, but by 2008 the total had soared to hundreds of millions. In fact the Internet has become so powerful that it has spawned an altogether new institution in the form of "virtual nations", being large-scale international communities of citizens with no limitations of space and time, no political boundaries, no territorial frontiers, no economic divisions, no social differences, indeed none of the traditional divisions that separate old-style nations. To cite Paul Hawken again, *"They amass sufficient power, wealth and shared purpose to acquire vast resources for those functions traditionally performed by nation states ... They are proving to be both the cause and effect of a monumental shift in economic, political and social structures right around the world."*

Finale

Finally, a miscellany of what is being done by people in nations large and small, rich and poor, democratic or not, capitalist or not, and North, South, West and East. Cuba has become the sole country to attain basic standards of sustainable development (and it has made itself largely immune to hurricane damage, in huge contrast to the U.S. Gulf Coast). Costa Rica plans to shift entirely to renewable sources of energy, and to become the first country to be carbon neutral. Israel has pioneered new technologies to increase water efficiency to a level several times greater than is usual around the world. South Korea has covered its hills and mountains with trees. Finland has outlawed non-refillable drink containers, while Ireland has imposed a tax on plastic shopping bags in supermarkets (cutting their use by more than 90%). Germany is exploring a major tax-shifting effort to increase energy taxes, offsetting this with reduced income taxes. Iceland is planning the world's first hydrogen-based economy. The Dutch have determined that the key to urban transportation lies with bicycles. Denmark has banned the construction of coal-fired power plants, as well as being a country with more members of environmental groups than Danes.

People are on the move!

Protecting the Global Environment by Starting from What We Can Do

Dr. Akira Miyawaki

15th Blue Planet Prize laureate (2006)

Born in Japan in 1928, he earned his Doctor of Science degree in 1961 from Hiroshima University. He became professor of the Institute of Environmental Science and Technology, Yokohama National University, in 1973 and professor emeritus at the said university in 1993. Since 1993, he has been director of IGES-Japanese Center for International Studies in Ecology (IGES-JISE). He was appointed chairman of the International Congress of Ecology in 1996. He demonstrated and proved that forest reconstruction based on "potential natural vegetation" enabled the restoration of fire-protection and environment-conservation forests that approximated natural forests. He established the forest restoration and reconstruction method called the "Miyawaki method," which has had concrete achievements in Japan and other countries.

Essential Challenge Posed by Environmental Problems

In the rapid progress of a large-scale development of nature, expansion of industrial sites and urbanization on a global scale, environmental problems are urgently requested to be dealt with and solved at the household, regional, national and international levels. Contemporary people are now consuming energy in vast amounts that were unthinkable in the past, and are living surrounded by a range of non-biological materials. For those people, environmental problems span in numerous fields and nature responds to those problems in a variety of phenomena, such as earthquakes and typhoons and associated fires, tsunami, and floods; other natural disasters such as repeated widespread droughts, environmental destruction caused by the development of natural areas, pollution of rivers, oceans, the air, and soil caused by chemical substances discharged from factories, the heat island phenomenon in desert-like cities full of concrete buildings, loss of biodiversity, and global warming, and these will all have a serious impact on us all. To solve these problems, a range of measures are being taken, including both technological and non-technological approaches. At present, such measures are widely implemented on a case-by-case basis, but there is a concern that the essence of what they are is being obscured because these environmental problems pose so vast and serious a challenge.

The essential challenge in tackling environmental problems is to protect life. Human beings think and feel with their abnormally-developed cerebral cortex. Humankind has used tools to develop science and technology and also developed the arts to express their pleasures and sorrows. To protect life means to pass on the genes that have been passed over for four billion years since the birth of a primitive life on earth, and to pass on the intelligence

and sensitivity of human beings, to future generations without fail. What we must protect for the future is these invaluable genes rather than the money and shares that are now attracting much attention in the world. We must maintain the biological environment as a total system by protecting the human life, their sensibility and genes, together with the biodiversity of animals, plants, and microorganisms that coexist with humankind.

The modern science and technology could be called "quantitative science." In the age of Goethe, the concept of "als Ganzheit" was a mainstream idea that viewed everything as a whole. However, following the invention of the thermometer and litmus paper at the end of the 18th century, it became possible to measure and quantify individual environmental factors in a specific timeframe and space. Since then quantitative science has made great progress.

By using advanced science and technology and nonliving materials, humankind reached the Moon. However, even with contemporary science, technology and medicine, no one out of the world's population of 6.7 billion can live for 200 or 300 years, even if all the money in the world is spent on developing immortality. Although biochemistry has progressed and genes can now be recombined, no biological cells have yet been created.

It might therefore still prove impossible to deal with the living environment of human beings only using quantitative science. We need to develop physicochemical research and at the same time foster research and measures from an aspect of life as a whole, which may still include a number of unknown factors.

Humankind as a Biological Being

Even if we develop new science and technology and become very rich, we will only be a part of nature and can survive sustainably only in our capacity as a "consumer" in the ecosystems that are based on the circulation of materials. Green plants are the only "producers" that support the lives of all creatures including human beings. We are thus parasites on green plants. Green plants, in particular indigenous forests composed of multilayered communities of trees, have a surface area of greenery that is 30 times as large as that of lawns and other single-layered plants, and provide the living foundation for human beings. At present, however, the area of indigenous forest has diminished substantially. For example in Japan, according to the results of our survey, the evergreen broadleaf (glossy-leaved) tree region, where at least 92% of the 120 million people in the country are still living, has diminished to only 0.06% of its original forest area.

Looking back on the history of human civilization, the world's first cultural regions were all in evergreen broadleaf tree regions, such as Mesopotamia, Egypt, Greece, and the Roman Empire. In the Mediterranean region, where it often rains in winter and is dry in summer without much rain, the leaves of evergreen trees are small and hard and have trichome to prevent water evaporation. For this reason, evergreen broadleaved trees in the Mediterranean region are called sclerophyllous trees, distinguishing them from glossy-leaved trees in Asia.

In ancient times, religions were generally polytheistic in the same way as the ancient Japanese Shinto religion. In an ancient poem from Mesopotamia, it is written that the first king named Gilgamesh killed the god of the forest as his first act as king. He then freely felled the trees in the forest, which was no longer protected by the god, to build a city and develop civilization. This clearly shows the idea that nature is something to be conquered for civilization.

When people consumed all the blessings from the forest, the city was destroyed and the culture ebbed away. Then the center of civilization moved from the Mediterranean sclerophyllous tree region to the northern broadleaved deciduous tree region which was mainly composed of European oaks. London, Paris, Berlin, and Brussels were the major cities in the region. Europeans who crossed the ocean to reach America built cities in Boston, Chicago, New York, Washington, and Philadelphia, which were all in areas with broadleaved deciduous trees, namely American oaks.

On the other hand, the Japanese are people who have been living in harmony with nature and worshipping all nature as multiple gods. Even today, most of the people live in glossy-leaved tree region which is green even in winter and Japanese cities with populations of one million or more except for Sapporo City, are all located in glossy-leaved tree areas. However, the numbers of these trees, which support our life, are decreasing sharply. Even in the world of green plants, we now have a lot of "fakes": almost all green plants we now see were planted by human beings as substitutes for indigenous trees, and so they are not genuine indigenous trees.

Indigenous trees are highly durable even under severe conditions. We must protect the remaining indigenous forests as the basis for human life and reforest deforested areas. Unless we do this, we will have no sound future even if science and technology develop further.

Plant Trees

Fossil fuels such as coal and oil are plants from 300 million years ago metamorphosed by ground pressure and heat. In the world of 300 million years ago, the Earth was in an interglacial period just as it is now, and the temperature and humidity were high. During that period, ferns grew densely and formed great forests. They absorbed CO_2 by photosynthesis and subsequently the forests were buried underground with the great changes the Earth was undergoing, and during the subsequent 300 million years the balance of material circulation on Earth was well maintained. After the onset of the Industrial Revolution in the latter half of the 18th century, humankind exploited coal and oil to use as energy sources. This could be seen as though an act of pulling out the carbon locked underground and spreading out into the air.

If we are to have a future where we really could live in, it is necessary to refrain from abusing materials and energy as if they were infinite resources, and instead reduce their consumption. However, we cannot reduce the use of electricity and numbers of cars and factories to zero if we want to maintain our present comfortable lifestyles. Then we must think positively in an arithmetic addition way instead of subtraction. Multilayered forests composed by planting a mix of various seedlings densely with seedlings of the primary tree of potential natural vegetation in the center and surrounded by various others, will be able to play an important role in disaster prevention and environmental protection and help conserve biodiversity. Forests absorb CO_2 and fixate the substance within them. About 50% of the dry weight of a tree is carbon. For example, if a seedling with a dry weight of 200 grams grows to become a tree with a dry weight of two tons including the root, stem and branches, one ton will be carbon. Unless the tree is incinerated, the carbon will continue to be confined in the tree and thus in the forest. Forestation will definitely improve the local environment and help prevent global warming.

We have so far planted 30 million or more trees with

cooperation from forward-looking governments, companies, organizations, and citizens. The planted regions exceed 1,600 in number, and are located in Japan, Malaysia, Thailand, the Philippines, India, China, South America (Amazon), Kenya in Africa, and Tasmania in Australia. At all of these areas, we identified potential natural vegetation through local ecological vegetation surveys and planted potted 30-centimeter well-rooted seedlings of the primary tree of the area's potential natural vegetation and various other tree varieties according to the law of the natural forest. In three years, the planted trees will no longer need maintenance or weeding, because by then an indigenous forest will begin to be formed through natural selection.

It is only a small act for a person to plant 10 to 20 trees, but if all people on Earth—6.7 billion citizens—plant 10 trees each, what will happen? Let us pursue forestation in creating real forests based on plant ecology together with intensive energy conservation, for the benefit of ourselves, those whom we love, for humankind, and for all living beings on the planet. This is Our Vision.

Fairness for Survival of Humankind

Dr. Emil Salim

15th Blue Planet Prize laureate (2006)

Born in Indonesia in 1930, he graduated from the Faculty of Economics of the University of Indonesia in 1958 and earned his Ph.D. in Economics from the University of California at Berkeley in 1964. He became Professor of Economics, University of Indonesia in 1972 and was appointed Indonesia's first environment minister in 1978. Winning international acclaim for his pioneering action in environmental policy aimed at creating a sustainable society, he has been actively involved in the activities of the United Nations. As a representative of the developing nations of Asia, he has contributed to the international community by exercising leadership in preservation of the global environment.

Many developed countries started to grow since the Industrial Revolution took place, fueled by fossil fuels as the main source of energy in the development of their industries (1790). Humans cannot *create* natural resources; they can only *transform* natural resources for development.

Humans cannot create coal as a source of energy; they can only transform coal to man-made energy. By the "law of thermodynamics," transforming natural resources (fossil fuel) into energy will release polluting gases, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gases, which are called *greenhouse gases*. These gases function to absorb some of the infrared radiation produced by the Earth's surface. The molecules of these various gases are released back into the atmosphere, where they trap heat in the Earth's atmosphere to provide a comfortable climate to support life. When the amount of greenhouse gases increases, the concentration will affect the heat trapped in the Earth's atmosphere and will raise global temperatures.

I. Climate Change

We are experiencing today an increase in the temperature of our globe caused by an increased density of greenhouse gases. The concentration of CO_2, the principal greenhouse gas in the atmosphere, reached 280 ppm prior to the Industrial Revolution. But the burning of fossil fuels raised the concentration of greenhouse gases up to 315 ppm in 1930 and to 380 ppm in 2008. If the "business as usual" pattern of development persists, by 2050 the concentration of greenhouse gases may well surpass 500 ppm.

The Intergovernmental Panel on Climate Change (IPCC) identified the 450-550 ppm concentration of greenhouse gases as the threshold above which global average temperature will be most likely be maintained in the range of 2.0-2.8 degrees Celsius above the pre-industrial level. To reach this level, global emission have to be cut by 25 to 40% of the 1990 greenhouse gas emission levels by 2020. Industrialized countries need to reduce 80% of their 1990 emissions by 2050, which is roughly a reduction of two tons of CO_2e per capita per year.

In Indonesia, sources of greenhouse gas emissions as CO_2equivalent originate from peat fires, changes in land use and forest use, energy pollution, the burning of waste, and agriculture and industry. The opening up of land and forests have had a significant impact on raising CO_2e emissions in Indonesia.

It is here that developing countries face a dilemma: to exploit land and forest for food production and other income-generating activities or to conserve it to remove greenhouse gases and to reduce global warming.

Because the expansion of hot water molecules and the melting of the ice at the poles are affected by global warming, the average sea level will rise 9 to 88 cm by 2100. In Indonesia the impact of a sea level rise is also evident: in Medan Harbor in North Sumatra it has risen by 7.83 mm, in Semarang in Central Jawa by 9.27 mm, in Surabaya in East Jawa by 5.47 mm, and in Jakarta by 4.38 mm, all registered recently. With Jakarta's coastal area subsiding and sea levels rising, flooding is becoming an increasingly frequent natural disaster.

Global warming also leads to coral bleaching. Combined with sea water acidification that kills plankton and destroys sea habitat, the sustainability of fishing is in jeopardy, and this hits the vulnerable Asian fishermen, who are the poorest people in the

region.

Archipelagos in the Pacific and Indian Ocean, like Indonesia, the Pacific Islands, the Philippines, the Maldives and other small independent island states are potential victims that could be swallowed up either partially or wholly by sea level rises, while none of the developing countries have the funds, technological capabilities or capacity to cope with the challenges of a sea level rise. For the *Alliance of Small Island States (AOSIS)*, the maximum tolerable threshold for greenhouse gas emissions that will ensure that small island states will not be drowned by a rise in the sea level is below 350 ppm.

Global warming influences the flow of warmer seas into colder ones, which affects local temperatures and induces changes in monsoon patterns, sea waves, storms and hurricanes, but also causes droughts. Water on land will evaporate faster, making fresh water an increasingly scarce commodity. This will also affect water dependent agriculture, especially irrigated rice production. There is hence an urgent need to discover seeds that are resilient against drought.

Global warming and climate change affect the extinction of species and eco-systems. Tropical regions of ASEAN and Papua New Guinea, which are rich in tropical biological resources, will suffer severe erosion of their biodiversity. IPCC projected that a surface temperature rise will increase the risk of increased extinctions among 20 to 30% of plant and animal species, combined with an erosion of biodiversity.

All these changes in global warming and climate will negatively affect human health. While old diseases, like malaria and tuberculoses, are not fully eradicated, new diseases will emerge that are closely linked with climate change. Clearly it will be the poor in the developing countries who will be the most vulnerable to the impacts of global warming and climate change.

Efforts to reduce climate change must therefore be a top priority for the developing countries. The grave consequences of climate change on developing countries are fully known. The problem is that developing countries have to cope with the equally, and perhaps currently more pressing problem of eradicating poverty. Poverty has to be eradicated today; climate change can perhaps be faced tomorrow by the developing countries, especially if this common problem is also tackled seriously by the developed countries. In the developing countries, the spending of one dollar to eradicate poverty will be reduced if this one dollar is spent to cope with climate change issues. Whereas in developed countries the spending of one dollar on climate change issues will reduce the amount spent on making life more comfortable.

The pressing issue for today is to develop partnerships between developed and developing countries to tackle both poverty eradication and climate change management simultaneously on the basis of the *United Nations Framework Convention on Climate Change (UNFCCC)* that recognizes the *"common but differentiated responsibilities"* of all countries based upon their respective capabilities.

This principle, according to *Nicholas Stern*, reflects several aspects of equity: *First*, that on the grounds of ability to pay, wealthier, more developed countries should support poorer countries in their effort to adjust to climate change; *Second*, it acknowledges that the largest share of historic and current global emissions have originated in the developed countries, and thereby

historical responsibility or the *"polluters pay principle"* applies; *Third,* it accounts for the relative size of per capita emissions in developing countries and the requirement to allow their relative share of emissions to rise to accommodate their aspirations for growth and poverty reduction. (**Stern**, 2006, 536).

While this principle has a moral, rational and an equitable logic, the facts are that its implementation in accordance with the UNFCCC is still being disputed and is considered by many developed countries as a stumbling block that prevents fair sharing of the burden between the countries of the globe in coping with climate change issues.

II. One Earth Contains A Diverse World

The Earth is one but the world is divided into developed and developing countries. And the differences between the developed and developing countries are real and many. Even among developed countries like the United States, the United Kingdom, Germany, France, Japan and Australia there are important differences as shown in Table 1

The United States with its 304 million people stands out as having the highest "per capita income at the Purchasing-Power-Parity rate" of US$ 46,970 and "total wealth per capita in 2000" of US$ 512,612 revealing "aggregate wealth the nation has produced in the past, reflecting the value of all goods, resources, and services, including natural, produced and intangible capital" (World Development Report 2010, 373). Of all this "total wealth," an amount of US$ 418,009 or close to 82% of this is "intangible capital that includes raw labor, human capital, social capital and other factors such as the quality of institutions."

Although Norway with US$ 58,090 per capita income for its 5 million people and Singapore with US$ 47,940 per capita for its 5 million people have surpassed the US income figure, nevertheless they have been left out of the table because their populations are small and the impact of their total national incomes on the global economy is rather limited.

The US also stands out as the highest in terms of "cumulative-energy-related carbon dioxide emissions during the years 1850-2005" with 324.9 billion metric tons of carbon dioxide emissions, which at 22%, gives the US the largest share of total world emission for 2005.

Table 1 Development Indicators for Selected Developed Countriesd

No		United States	United Kingdom	Germany	Japan	France	Australia	World Total / Average
1	Population, Millions 2008	304	61	82	128	62	21	**6.692**
2	PPP Gross National $Income & per Capita 2008	46,970	36,130	35,940	35,280	34,400	34,400	**10,357**
3	Total Wealth $ per Capita 2000	512,612	408,753	496,447	493,241	468,024	371,031	**95,680**
4	Intangible Capital $ per Capita 2000	418,009	346,347	423,323	341,470	403,874	288,686	**74,998**
5	Average Annual Gross Domestic Product Average Annual % Growth 2000 - 2008	2.5	2.5	1.2	1.6	1.7	3.3	**3.2**
6	Cumulative Energy-related Emissions in Billion Metric Tons 1850 - 2005	324.9	68.1	117.8	46.1	31.7	12.5	**1.1691**
7	Per Capita Metric Tons Emissions. 2005.	19.7	8.8	9.9	9.5	6.4	18.5	**4.2**
8	Share of Annual World Total (%) Energy-related CO_2 Emissions	22.0	2.01	3.8	4.57	3.0	1.42	**100%**
9	Carbon Intensity Metric Tons of CO2 per Thousand $ of GDP 2005	0.47	0.28	0.32	0.31	0.21	0.58	**0.47**

Source: World Development Report 2010

The United Kingdom, Germany, France and Japan had in 2008 similar "high national incomes (PPP) per capita" of between US$34,000 and US$ 36,000. The "total wealth per capita" varied in 2000 between the lowest for the UK at US$ 408,753 and the highest for Germany at US$ 496,447. Similarly "intangible capital" varies between the lowest for Japan at US$ 341,470 and the highest for Germany at US$ 423,323.

Australia is rather unique. The country has a small population of 21 million compared to 128 million people in Japan. Its PPP income per capita of US$ 34,400 was close to Japan's income of US$ 35,280 in 2008. But it has a high "energy-related carbon dioxide per capita emissions" of 18.5 metric tons, almost double Japan's per capita emissions of 9.5 metric tons. Australia's "carbon intensity per thousands of dollar GDP" is 0.58 metric tons, almost double that of Japan (0.31) in 2005. Australia's "cumulative energy-related carbon dioxide emissions 1850-2005" was 12.5 metric tons compared to Japan's 46.1 metric tons. Australian emissions are 37% of Japan's emissions, while its population is only 16% of Japan's population.

With their high income, total wealth and intangible capital, developed countries have ample room to reduce carbon dioxide emissions without reducing their standard of living.

If we analyze selected developing countries' development indicators as in Table II, it becomes clear that the Republic of Korea, Brazil, South Africa, China, India and Indonesia together have 2.984 billion people or close to 45% of the world population of 6.692 billion. In terms of "income," "total wealth" as well as "intangible capital," all these heavily populated developing countries are far below the developed countries' level.

It is in terms of "cumulative energy-related emissions 1850-2005 per billion metric tons" and "per capita carbon dioxide emissions" that developing countries are lower than the developed countries.

Table 2 Development Indicators for Selected Developing Countries

No		Republic of Korea	Brazil	South Africa	China	Indonesia	India	World Total / Average
1	Population, Millions 2008	49	192	49	1.326	228	1.140	**6.692**
2	PPP Gross National $ Income & per Capita 2008	28,120	10,070	9,780	6,020	3,830	2,960	**10,357**
3	Total Wealth $ per Capita 2000	141,282	86,922	59,629	9,387	13,819	6,820	**95,680**
4	Intangible Capital $ per Capita 2000	107,864	70,526	48,959	4,208	8,015	3,758	**74,998**
5	Average Annual Gross Domestic Product Average Annual % Growth 2000 - 2008	4.5	3.6	4.3	10.4	5.2	7.9	**3.2**
6	Cumulative Energy-related Emissions in Billion Metric Tons 1850 - 2005	9.0	8.8	14.1	94.3	6.8	28.6	**1.1691**
7	Per Capita Metric Tons Emissions. 2005.	9.3	1.8	7.1	3.9	1.6	1.1	**4.2**
8	Share of Annual World Total [%] Energy-related CO_2 Emissions	1.69	1.26	1.25	19.06	1.31	4.33	**100%**
9	Carbon Intensity Metric Tons of CO2 per Thousand $ of GDP 2005	0.44	0.21	0.83	0.96	0.49	0.47	**0.47**

Source: World Development Report 2010

Only China with 94.3 billions tons has high "cumulative carbon dioxide accumulated during 1850-2005" compared to Germany (117.8 billion tons) and the USA (324.9 billion tons). India with 28.6 billion tons of "cumulative energy-related carbon dioxide emissions 1850-2005" has a lower level than the USA, the UK,

Germany, France and Japan. These performances have been reached by China with a population of 1.326 billion and India with 1.140 billion people.

With low incomes per capita, low total wealth and intangible capital but large populations, the developing countries have to face the humane task of raising people's standards of living. This drives developing countries growth rates, ranging from a low 3.6% (Brazil) to a high growth rate per annum of 10.4% (China) during 2000-2008, while developed countries have achieved a lower rate of growth ranging from a low 1.2% (Germany) to a high 3.3% (Australia).

But high growth also leads towards high pollution. This explains why the "carbon intensity" of developing countries has a higher range, from 0.47 (India) to 0.96 (China) than the developed countries, which range from 0.21 (France) to 0.58 (Australia).

Lack of clean technology, technical know-how, lack of the capacity to implement a low-carbon growth path and limited funding has forced developing countries to follow the "business as usual" model of development, with rising greenhouse gas emissions.

The burden of responsibility to save our only one Earth therefore rests on the shoulders of the developed countries who have the financial capacity, technology, intangible capital and influence to lead this diverse world, and assist the developing countries in following sustainable development along the low carbon pathway.

This was the rationale behind the creation of the Annex I Parties in the UNFCCC and the Annex B Parties in the *Kyoto Protocol,* consisting of developed countries that are requested to put a legally binding ceiling on their emissions on an individual country basis to enable them together to reduce greenhouse gas emissions.

On the basis on their scientific findings, the IPCC recommended that 25 to 40% of CO_2e emission levels for 1990 should be reduced by 2020 in order to bend the curve of CO_2e emissions so that it would not exceed, but instead would stabilize at the 450-490 ppm level to keep global warming below the additional 2.0-2.4 degrees Celsius level above pre-industrial revolution temperatures.

Data submitted to the UNFCCC reveals that up to 2007, greenhouse gas emissions from the Annex I Parties of the UNFCCC have been reduced only by 4% below the 1990 level, and the industrialized countries in Annex B to the *Kyoto Protocol* have achieved around 16% below the Kyoto baseline. Much of the reduction in greenhouse gas emissions comes from the economic decline of economies in transition in Eastern and Central Europe in the 1990s. But since 2000, emissions from this group of countries are also increasing. In spite of the recent economic crisis that brought a slowdown in the global economy, greenhouse gas emissions are still increasing. This indicates that no fundamental change in development towards a low carbon growth pathway has taken place, in spite of the fact that the developed countries have the financial and technological abilities, and the developing countries are anxious to cope with reducing greenhouse gas emissions together with eradicating poverty.

With this trend in unsustained growth, the diverse countries of the world are endangering the sustainability of our only one Earth.

III. Fairness for Survival of Humankind

Since the *Second Development Decade 1970-1980* was launched four decades ago, the stumbling block has always been the reluctance of the developed countries to transfer technology and

financial funds to the developing countries. This is now being repeated in settling the issue of climate change. There is no doubt that developing countries are increasing their greenhouse gas emissions from the energy needed to support their development. China has increased their "current greenhouse gas emissions" to 7.5 $GtCO_2$, which has surpassed the US figure of 7.4 (see Table 3).

China's "cumulative CO_2 combustion emissions 1850-2004" are 27% of those of the US. China's "GHG emissions per capita" are 23% of those emitted by the US. China uses only 21% of the amount the US used for "residential electricity consumption." Fossil fuel is used for only two vehicles per 100 people in China compared to 80 vehicles per 100 in the US.

This comparison must be understood while keeping in mind the huge difference in China's population of 1.330 million as against the US population of 304 million.

Table 3 Comparison of Energy Statistics for the US and China

No		United States	China
1	Population (Millions)	304	1330
2	Greenhouse Gas Emissions per Capita (tCO_2 e)	25.0	5.8
3	Current Greenhouse Gas Emissions (Gt CO_2 e)	7.4	7.5
4	Cumulative CO_2 Combustion Emissions 1850 - 2004 (Gt)	325	89
5	Residential Electricity Consumption (TWh)	1.359	292
6	Vehicles per 100 Population	80	2

Source: Deborah Seligsohn, Robert Hilmayr, Xiaomei Tan, Lutz Weischer, "China, the United States, and the Climate Change Challenge" in World Resource Policy Brief, October 2009

In spite of these differences, the Chinese Government has launched its "China's National Climate Change Program 2007" with bold initiatives to reduce the energy intensity of the GDP by 20% over the period from 2006 to 2010, increasing alternative energy in the fuel mix to 15% by 2020 and increasing forestation cover to 20% of China's land mass by the end of 2010. (Seligsohn cs, in World Resource Institute Policy Brief, October 2009).

In their "share of the annual world total of energy-related CO_2 emissions," both the US (22%) and China (19.06%) share almost half of the world's emissions. It will be very important for both countries to decide to cut greenhouse gas emissions to prevent global warming overshooting the 2 degrees Celsius above the pre-industrial level by 2050.

The *Kyoto Protocol,* which came into force in 2005 as the UNFCCC's *binding agreement,* has set for the *Annex I* industrialized countries a target amount of an average 5.2% reduction against the 1990 level over the period from 2008 to 2012. This has not been reached. For the post 2012 period, the shared vision of Bali COP 13 was to strive for 450 ppm CO_2e concentrations to prevent surpassing the 2 degrees Celsius increase in global warming above the pre-industrial level, by reducing CO_2e emissions by the developed countries to between 25 and 40% of the 1990 levels by 2020.

To achieve the reduction target, the IPCC has stressed that it can be achieved by deploying a portfolio of technologies that are currently available or expected to be commercialized in the coming decades. It requires effective incentives for the development, acquisition, deployment and diffusion of technologies and the addressing of related barriers (IPPC, Climate Change 2007, Synthesis Report).

This shared vision to limit CO_2e emissions within a specific

time frame requires a changing paradigm of economics that needs to be constrained by social and ecological considerations. It also requires fair trade, with *fairness* in development as the main driving force, instead of free trade and a complete disregard for the survival of the poor in developing countries.

In these climate change negotiations there are many rational solutions that are do-able. To come to an agreement, the main stumbling block is that the "business as usual" paradigm is used with each nation's narrow economic and political interests within a short-term perspective. National surpass global interests. Human wants exceed human needs. To save our only one Earth, the world needs leaders with a global perspective that goes beyond national boundaries.

It also requires changing the conventional economic development paradigm into the sustainable development paradigm already launched at the 1992 Rio-de-Janeiro Summit on Environment and Development and reemphasized at the 2002 Johannesburg Summit on Sustainable Development.

For too long the world has witnessed diverse nations plundering the Earth, where the early ones gained substantially while the latecomers suffer the most. As latecomers, the developing countries need to be given a fair opportunity to eradicate hunger, disease, poverty and illiteracy. Unless they are given the technology, the capability and the necessary funding, developing countries are forced to demand a "fair right to pollute the atmosphere."

In the meantime, in striving for the survival of humankind, the nations that are the developing countries must continue to move forward and muddle through to search for that particular road to eradicating poverty that also simultaneously reduces greenhouse gas emission that is based on a spirit of fairness.

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Notes

Part 2 Conditions for Survival

1 Dr. Dennis L. Meadows

2 Dr. Gro Harlem Brundland: Blue Planet Prize laureate for 2004

3 The ecological footprint is an indicator that shows how much we rely on the natural environment in leading our lives. It is a measure of human demand expressed as the area of biologically productive land and sea needed to supply the required resources and to absorb CO_2 released by burning fossil fuels. The indicator is 1.0 if the total area of biologically productive land and sea on the Earth is needed to meet the requirement. It was about 1.3 in 2005.

4 Mr. Lester R. Brown

5 Questionnaire on Environmental Problems and the Survival of Humankind (Asahi Glass Foundation): Conducted annually since 1992 and targeting governmental officials and experts in the private sector around the world. The results are publicly announced in the form of a report. (Number of people asked to reply: about 4,000, reply rate: 15 to 19%, number of respondents: 650 to 700)

6 The urban population represents the number of people living in the areas that are defined as cities according to the criteria of each country. In every year, the data as of July 1 is used for that year.
Source: World Urbanization Prospects: The 2007 Revision Population Database

7 Meeting of energy ministers of the G8 (The United States, Canada, Germany, France, Italy, the United Kingdom, Japan, and Russia) + 3 (China, India, and North Korea) held on June 8, 2008

8 International Energy Agency (IEA): An international organization that conducts surveys and prepares statistics on the world's energy issues and announces related data

9 The IPCC is an organization established through cooperation between the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). Researchers from various countries make scientific, technological, social, and economic assessments on global warming caused by greenhouse gases for the organization, which makes the results, including knowledge and information, widely accessible to the public as its principal role. The fourth assessment report was created by about 450 authors and about 800 supporters for authors from about 130 countries.

10 Precipitation per unit time expressed in millimeters

11 Here water resources mean the annual precipitation in each country used deducting the the amount of evaporation.

12 An article dated May 22, 2007 in the Guardian, a British national daily newspaper, reported as follows: according to some Chinese cancer researchers, a lot of chemical factories and industrial facilities were established along rivers, into which untreated wastewater has been released. Moreover, underground water is polluted by the excessive use of fertilizers and insecticides. In addition, over the period from 1991 to 2000, the number of death due to cancer increased by 18% in urban areas and by 11% in rural areas.

13 The State of Food and Agriculture 2009, FAO

14 According to a book on the world's food production and biomass energy and their prospects for 2050. Author: Hiroyuki Kawashima, published by the University of Tokyo Press in 2008

15 Countries shifting from a centrally planned economy to a market economy, including former Soviet Union countries, countries in Eastern Europe, China, Mongolia, and Vietnam

16 Press release from the FAO Liaison Office in Japan (LOJA PR09/21-No. 142)

17 Press release from the FAO Liaison Office in Japan (LOJAPR09/21-No. 143)

18 Press release from the FAO Liaison Office in Japan (LOJAPR09/21-No 143)

19 Climate Change 2007: Synthesis Report, Summary for Policymakers, IPCC

20 Reference: The Atlas of WATER: Mapping the World's Most Critical Resources, Robin Clarke and Janet King

21 Millennium Development Goals (MDGs): The United Nations Millennium Declaration, which set the goals for the 21st century, was adopted at the United Nations Millennium Summit held in New York in September 2000. The Millennium Development Goals were set as a framework incorporating the Declaration and the international development targets adopted at the major international conferences and summits held in the 1990s. The goals to be achieved by 2015 are to eradicate extreme poverty and hunger; achieve universal primary education; promote gender equality and empower women; reduce child mortality rates; improve maternal health; combat HIV/AIDS, malaria, and other diseases; ensure environmental sustainability; and develop a global partnership for development.

22 In addition, it was promised that support would be given for developing countries to formulate and implement development strategies to adapt to climate change and that the development and commercialization of second-generation biofuels would be accelerated. The biofuels are to be produced from non-food plants and uneatable biomass, in order to make the policies for the sustainable production and use of biofuels compatible with measures for food security.

23 Dr. Charles D. Keeling: Blue Planet Prize laureate for 1993

24 Annex I Countries refer to the Annex I Parties to the United Nations Framework Convention on Climate Change. These countries have numerical emission reduction targets and are listed in Annex B of the Kyoto Protocol. Specifically, they are Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, the Czech Republic, Denmark, Estonia, the European Union, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lichtenstein, Lithuania, Luxembourg, Monaco, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, the Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, the United Kingdom, and the United States.

25 Major numerical targets for CO_2 emissions reduction (from the 1990 level) set out in the Kyoto Protocol: Eight percent for the EU, seven percent for the United States, and six percent for Japan, Canada, Hungary, Poland, and others. The United States, however, abandoned the Kyoto Protocol for the reason that the Protocol would badly affect their economy and that developing countries were not participating in it.

26 Human beings are both social and biological beings.

27 Lord (Robert) May of Oxford

28 Dr. Norman Myers

29 CO_2 emissions: In this case, decreases in the amount of CO_2 absorbed by forests are calculated as CO_2 emissions.

30 Biodiversity friendly products and services are to be sold at higher prices.

31 The TEEB research project was launched at the meeting of the environment ministers of the G8 + 5 held in Potsdam, Germany. It is intended to create survey reports that will show the economic and social losses caused by the loss of ecosystems and biodiversity and to propose specific measures to deal with the biodiversity crisis.

32 No past reports have shown that genetically modified organisms have greatly changed biodiversity in Japan. There is however no scientific guarantee that these organisms will not have an impact on biodiversity in the future. Genetically modified organisms might invade local ecosystems, intercross with native species, and the substances generated by genetically modified organisms might also have an impact on native species.

33 Dr. James E. Lovelock

34 Dr. Amory B. Lovins

35 Anticipatory approaches might fail, and it is therefore necessary to constantly review and make corrections to the approaches.

36 Dr. Paul R. Ehrlich: Blue Planet Prize laureate for 1999

37 Hotspots mean areas with a lot of indigenous species, where ecosystems are seriously threatened to destruction. Although these areas account for only about several percent of the Earth's surface, 75 percent of mammals, birds, and amphibians that are critically endangered and 50 percent of all vascular plants and 42 percent of all land vertebrates are living in those areas.

38 International funding system to cover the additional cost to be paid to contribute to solving global environmental problems in the projects implemented in developing countries and countries in transition

39 An international NGO that conducts biodiversity conservation activities across the world, which was also the Blue Planet Prize laureate for 1997

40 System in which funds flow continuously from developed countries which are economic beneficiaries of biodiversity to developing countries blessed with biodiversity. It is discussed as a means of conserving biodiversity utilizing the market mechanism, and studies are being made on how to trade conservation duties among countries; international support for biodiversity conservation-related offset activities (activities that offset the loss of biodiversity due to development activities in one area with conservation of biodiversity in other areas); taxation according to the impact on biodiversity; and on the certification systems for biodiversity friendly products.

41 toe: tons in oil equivalent (amount of energy derived from one ton of oil), Mtoe: amount of energy derived from one million tons of oil

42 The Photovoltaic Power Systems Programme (PVPS) represents an agreement designed for developed countries to improve their research abilities and exchange more information on photovoltaic power generation. Led by the IEA, a range of projects for the application of photovoltaic power generation are conducted through the network of R&D teams of member states.

43 In addition to solid waste released from households and manufacturing processes, this includes waste gas, wastewater, and emissions from automobiles.

44 Based on the idea that manufacturers should be responsible not only for the manufacture, sale, and use of their products but also for the disposal of those products, manufacturing companies are encouraging the recovery, recycling, and appropriate disposal of wasted products, such as end-of-life automobiles and home electrical appliances.

45 In order to support the lives of people in developing countries, agricultural and other products are continuously purchased at appropriate prices that are higher than local market prices. Also for sustainable development, environmentally friendly production methods are recommended to producers and higher prices are paid to products manufactured by such methods. There are also international organizations such as the FLO, which are promoting the labeling of fair trade products based on certain standards, with a view to helping consumers identify these products more easily.

46 Initiatives to certify products that contribute to the sustainable use of natural seafood and to the conservation of marine ecosystems, as represented by the MSC certification program led by the WWF and the Marine Stewardship Council (MSC)

47 Third-party organizations check whether forest management methods meet the predefined targets and certify the methods that actually meet the targets with an eye to promoting the conservation of forest ecosystems and the protection of rare species. Organizations like the FSC, PEFC, and Japan's SGEC are engaged in these certification activities.

About the Asahi Glass Foundation

The Asahi Glass Foundation was established in 1933 as the Asahi Foundation for Chemical Industry Promotion in commemoration of the 25th anniversary (in 1932) of the foundation of Asahi Glass Co., Ltd. Over most of its first half century, excluding the confused post-war period, the Foundation focused primarily on fostering research in applied chemistry. Subsequently in 1990, the Foundation undertook the overall redesign of its programs, expanding the target of its research grants and establishing its commendation program. At the same time, it changed its name to the Asahi Glass Foundation. Since then, the Foundation has been continuing its activities focusing on (1) the research grant program designed to foster science and technology for future generations and on (2) the Blue Planet Prize program as its two mainstays, with the aim of contributing to the creation of a society and culture that provides a truly rich life to a wide range of people, and including initiatives to solve global environmental problems.

Conditions for Survival

Toward a “Solar Energy-Based Society” Full of Vibrant Life

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