Special Round Table Conference on Global Environment Problems

# DATA

## Deciphering "Conditions for Survival"

| Data Book |

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Population
Life and Economy
Energy
Water
Food
Global Warming
Biodiversity

THE ASAHI GLASS FOUNDATION

Special Round Table Conference on Global Environment Problems

# Deciphering "Conditions for Survival"

## | Data Book |

THE ASAHI GLASS FOUNDATION

# Preface to Data Book: Deciphering "Conditions for Survival"

*Conditions for Survival: Toward a "Solar Energy-Based Society" Full of Vibrant Life* was recently published as the final report of the Special Round Table Conference on Global Environment Problems, consisting of trustees and councilors of the Asahi Glass Foundation.

The round table conference met eight times over a period of nearly three years. Its knowledgeable members exchanged high-quality, evocative opinions.

The secretariat office of the Foundation prepared numerous documents to serve as the basis of these discussions, especially those data related to the environment. However, as it was not possible to list all the data in the report, quite a few were omitted.

Each of the sets of data provided is rich in suggestions and alone represents a specific aspect of environmental issues. *The Data Book: Deciphering "Conditions for Survival"* is published with the aim of deepening readers' understanding of the final report "Conditions for Survival" and enabling them to review issues related to the global environment by just viewing the data.

In compiling this data book, we contrived a method of presenting the data so that they could be easily understood by as many readers as possible. The sequence of data-layout was designed for readers to easily follow it in accordance with a given context.

Each set of data is provided together with explanations as to why it is listed or what it means, as well as what the figures or tables indicate.

By reading this data book, I hope that you will deepen your understanding of the final report "Conditions for Survival" and successfully decipher the issues related to the global environment.

Please allow us to express our heartfelt gratitude to Mitsubishi Research Institute, Inc. and Ast Creative Co., Ltd.: the former helped gather and organize a great deal of data for the publication of the data book and supported discussions at roundtable conferences, while the latter ensured data book becomes readable, which could easily have become dull and uninteresting.

Keiichi Uchida
Advisor, the Asahi Glass Foundation

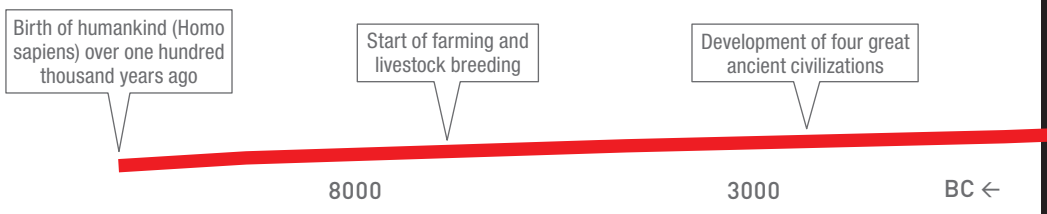
# Departure from "The Limits to Growth"

# I

Changes in global population over significant period of time from the birth of Homo sapiens to today eloquently explain the abnormality of the population increase from the 20th century onward.

DATA 001 | **Figure 1-1 Trends in global population**

The increase in global population was extremely slow prior to the Industrial Revolution which took place during the 18th to 19th century. However, after the Industrial Revolution, the rate of the population growth soared drastically. The global population was 2.5 billion in 1950 and reached 5 billion in 1987, thereby doubling in the course of around four decades. It is estimated that it will reach 9.1 billion by 2050.

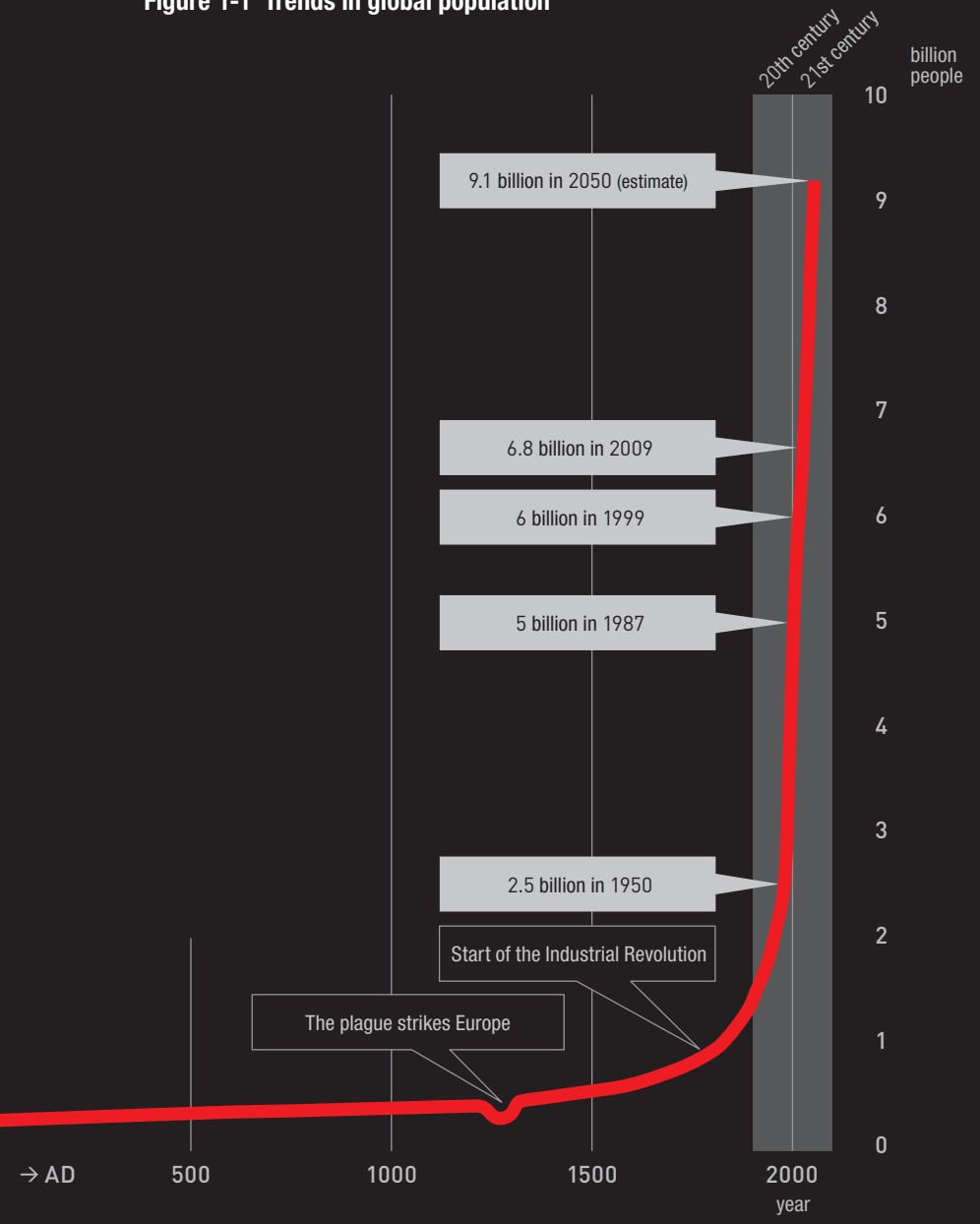



Source: the website of the United Nations Population Fund
[http://www.unfpa.or.jp/p_graph/pgraph.html (Last updated: 2009-06-22)]





**Figure 1-1 Trends in global population**



# I Departure from "The Limits to Growth"

Published in 1972 by the Club of Rome, *The Limits to Growth* warned that if the population and industrial production activities continued to increase, the resultant depletion of resources and deterioration of the environment would cause the growth of humankind to reach its limit within the next 100 years. In spite of that, the global population has continued to increase even after 1970. The following data shows the changes in the substances that support the activities of humankind, the supply of primary energy and the consumption of grain from 1970 onward, in comparison with population changes during the same period.

DATA 002 | **Figure 1-2 Trends in global population, the supply of primary energy and the consumption of grain (1970 onwards)**

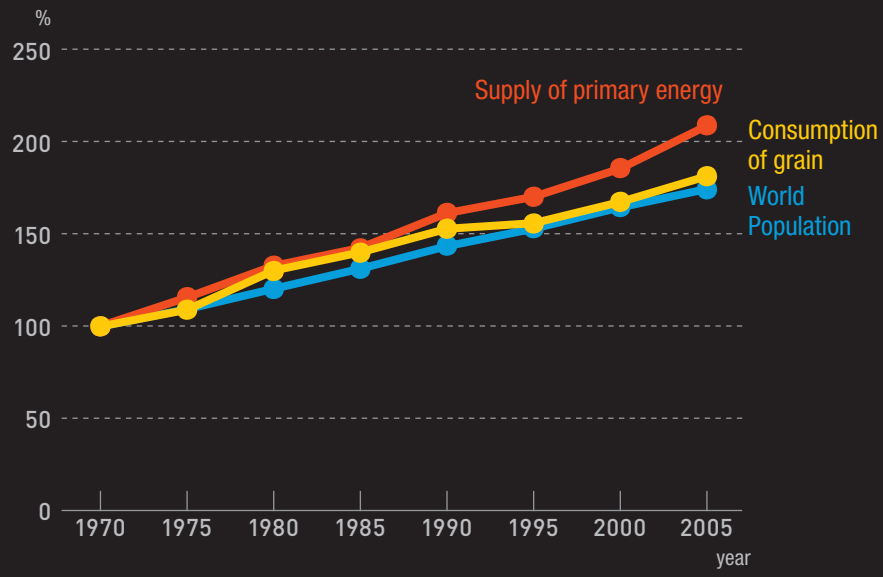
The consumption of grain and the supply of primary energy increased by about 1.8-fold and by about 2.1-fold, respectively, in the 35-year period from 1970. The rate of increase is equal to or greater than that of the population increase (a little less than 1.8-fold).







**Figure 1-2 Trends in global population, the supply of primary energy and the consumption of grain (1970 onwards)**




Source: World Population Prospects: The 2008 Revision, UN; BP Statistical Review of World Energy 2007; and data on the demand, production and term-end inventory rates of grain prepared by the Japanese Ministry of Agriculture, Forestry and Fisheries

# I Departure from "The Limits to Growth"

Humankind lives on the blessings of nature: energy, resources, water and food. The ecological footprint is an index of the amount of natural environment required by humankind. It also shows the load placed on the Earth by human activities in a numerical manner.

DATA 003 | **Figure 1-3 Humanity's Ecological Footprint**

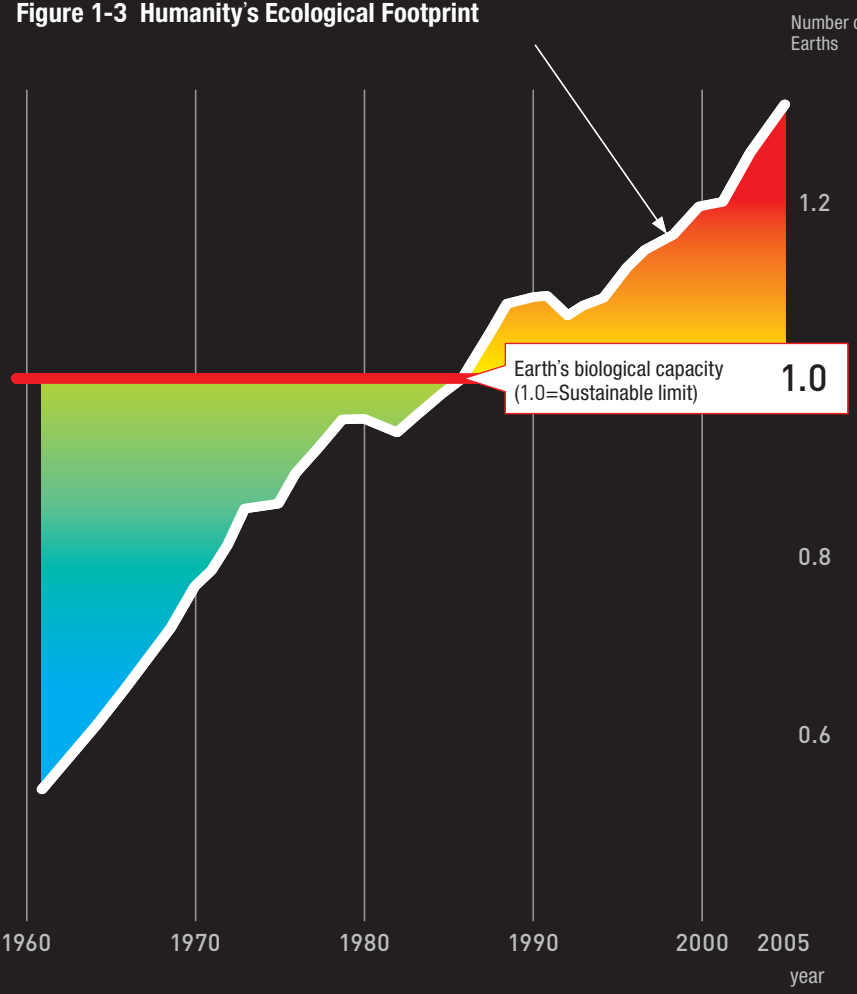
Ecological Footprint is a measure of human consumption and waste generation expressed as an area of biologically productive land and water needed to provide ecological resources and land to absorb the $CO_2$ released by burning fossil fuels. The index is numerically indicated on the assumption that the total area of the land and shore on Earth with biological productivity is 1.0 (this level is considered as the world's bio capacity). Social and economic activities around the world caused humankind's ecological footprint index to exceed 1.0 by the mid-1980s. By 2005, the resources consumed by humankind's activities and the resultant waste had outstripped the amount of resources the Earth can sustainably supply and the amount of waste that can be absorbed by nearly 30%. In other words, humankind today needs a globe that is 1.3 times larger than its actual size.







**Figure 1-3 Humanity's Ecological Footprint**




Source: Living Planet Report 2008, WWF

The question is: how do numerous experts throughout the world see the crisis humankind is facing toward its existence as a result of environmental deterioration?

DATA 004 | **Figure 1-4 The Environmental Doomsday Clock – Shift in time**

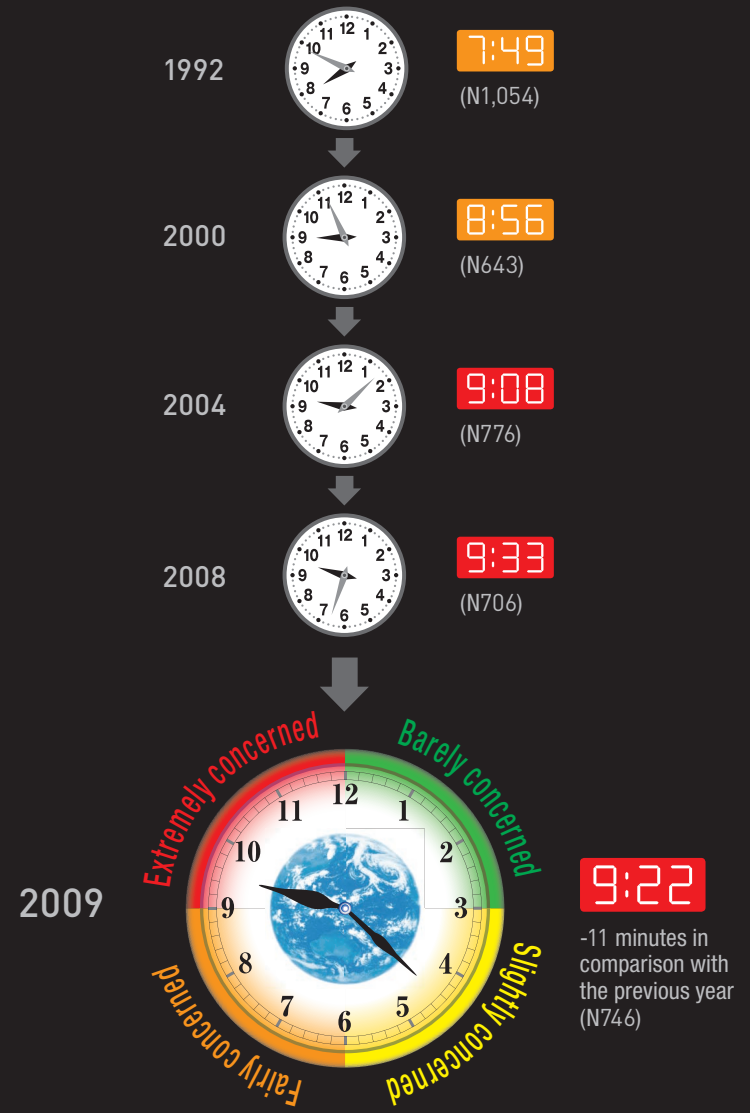
The Asahi Glass Foundation has conducted annual surveys with experts worldwide, using the hands of the clock to indicate the level of awareness of the crisis humankind is facing toward its existence as a result of environmental deterioration. The first survey was conducted in 1992, when the Clock struck 7:49. Since then, the hands have advanced each year, striking 9:22 in 2009. In other words, many experts are “extremely concerned.”







**Figure 1-4 The Environmental Doomsday Clock – Shift in time**




Source: 2009 Survey on Global Environmental Issues, the Asahi Glass Foundation

Adopted at the 1992 Earth Summit, Agenda 21 is an action plan for countries to realize sustainable development. The plan contains numerous items concerning the conservation of the global environment. How do experts review the progress of the major items in the plan? The following shows the results of the surveys conducted in the last 17 years.

DATA 005 | **Figure 1-5 Progress of Agenda 21**

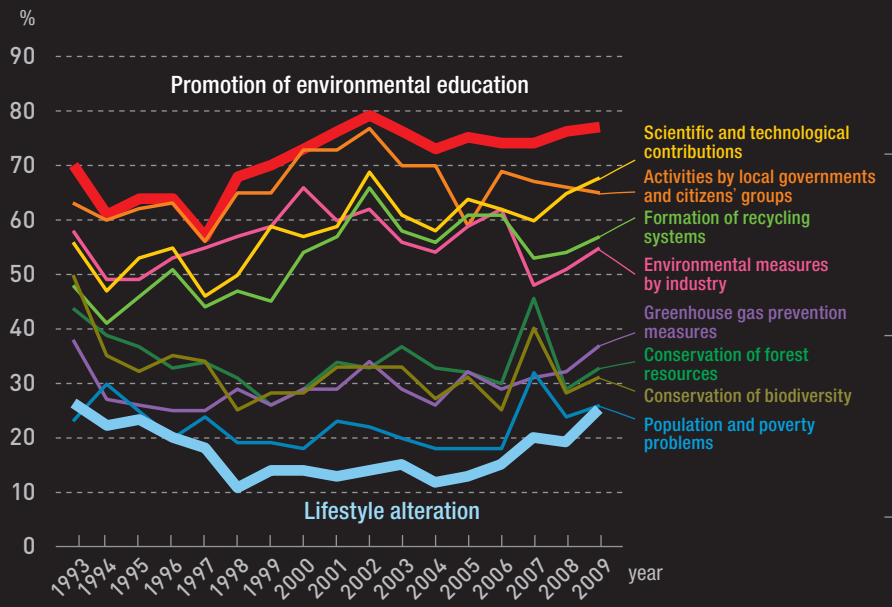
Since the initiation of the survey in 1993, its results have been largely divided into two groups: the top five items and the bottom five items. “Promotion of environmental education” has remained in the top position throughout the 17-year period and can be regarded as consistently progressing. In contrast, “Lifestyle alteration” has mostly remained at the bottom, indicating that hardly any progress has been made in this regard. The 2009 results showed similar tendencies to those of previous years: “Promotion of environmental education” is regarded as having progressed the most, while the progress in “Lifestyle alteration” and “Population and poverty problems” remains stagnant.

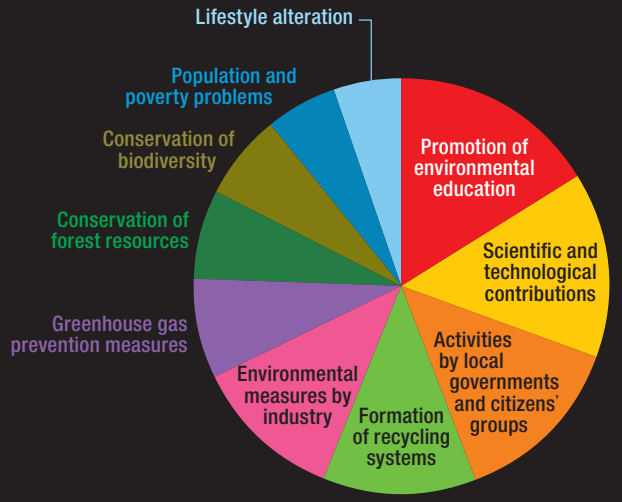






**Figure 1-5 Progress of Agenda 21**




Source: 2009 Survey on Global Environmental Issues, the Asahi Glass Foundation

# Human Activities Face limitations

**Increase in population and change in lifestyles**

- Explosive population increase
- The Progress in urbanization
- Gaps in economy and quality of life

**Energy resources**

- The finite nature of resources
- Reserves in energy resources
- Consumption and supply of energy
- Energy disparity

**Sustainability and fairness in availability of water resources**

- Unevenly distributed freshwater resources
- Distribution and circulation of water
- Use of water resources
- Problems with water supply
- Gaps in the amount of water consumption
- Agricultural production and water

**Sustainability and fairness of food securement**

- Food production and its problems
- Gaps in food, nutrition and hygiene
- Changes in eating habits and associated problems
- Problems in the fishing industry

II

## Ⅱ Human Activities Face limitations

### Explosive population increase

Among the issues concerning the global environment, what is considered as possibly being the most influenced by the increase in the world population?

DATA 006 | **Figure 2-1 Influences of population problems (2006)**

Aggravation of poverty, destruction of the natural environment and food shortages were specified as issues having been influenced most by population problems.







**Figure 2-1 Influences of population problems (2006)**


Source: 2006 Survey on Global Environmental Issues, the Asahi Glass Foundation

## Ⅱ Human Activities Face limitations

### Explosive population increase

The populations of developing countries will continue to increase, having major effect on global environmental problems.

DATA 007 | **Figure 2-2 Outlook for world population: developed regions versus developing regions (moderate-range estimate)**

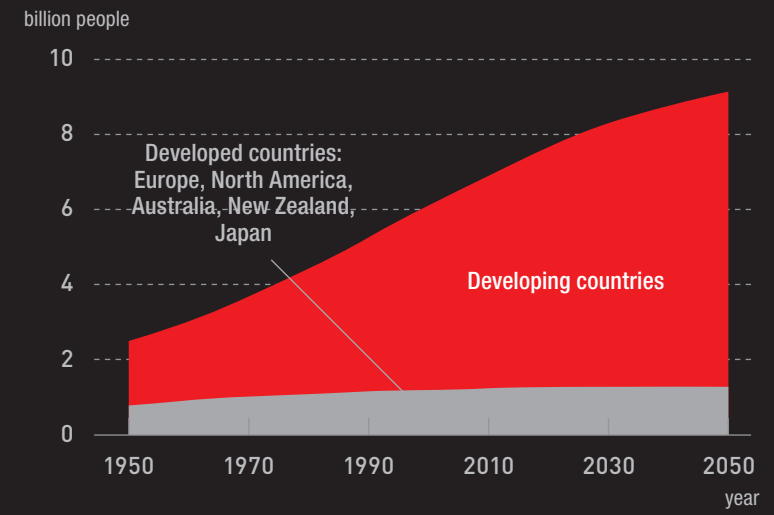
A comparison of population changes between developing countries and developed countries from 1950 onward shows that the increase in the world population stems mostly from developing countries. In 1950, developing countries accounted for nearly 70% of the world population. It is estimated that this figure will rise to nearly 86% by 2050.







**Figure 2-2 Outlook for world population: developed regions versus developing regions (moderate-range estimate)**




Source: World Population Prospects: The 2008 Revision, UN

# Ⅱ Human Activities Face limitations

## Explosive population increase

The concept of sustainable development means that, despite limitations in the growth of humankind, it remains imperative to have economic growth to solve poverty problems, and therefore future growth needs to occur in a sustainable manner. Estimates of the distribution of the world population by region show how large the size of the regions are that are necessitating population growth in order to mitigate poverty.

DATA 008 | **Figure 2-3 Distribution of world population by region (2009)**

The world population in 2009 is approximately 6.8 billion. By region, Asia accounts for nearly 60%. China and India are the most populated countries in Asia, accounting for 19% and 18% of the world population, respectively. Combined, the two countries account for nearly 40% of the world population.

**Figure 2-4 Outlook for world population by region (moderate-range estimate)**

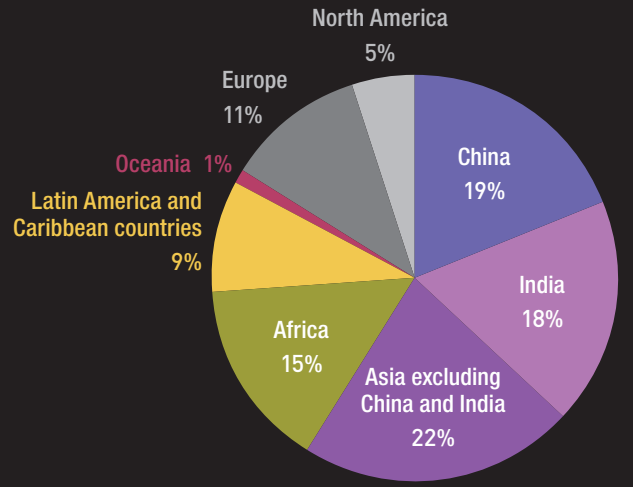
In the future, the increase in the world population will be concentrated in Asia and Africa. By country, China and India in particular make up a large part of the world population. The population of China, currently the country with the highest population in the world, is projected to continue to increase until 2030 before beginning to decline. The population of India, currently the country with the second-highest population, is projected to outnumber that of China around 2030 and continue to increase even after that.





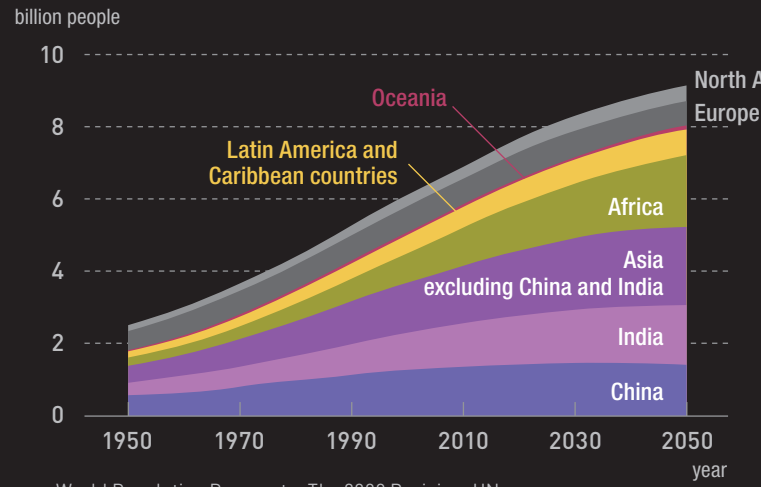


**Figure 2-3 Distribution of world population by region (2009)**




Source: World Population Prospects: The 2008 Revision, UN

**Figure 2-4 Outlook for world population by region (moderate-range estimate)**




Source: World Population Prospects: The 2008 Revision, UN

Around the world, the population increase and the expansion of economic activities have hastened the concentration of populations in urban areas.

DATA 009 | **Figure 2-5 Cities with populations of over one million people (2002)**

Large cities with populations of over one million people can be found in all parts of the world. Urbanization has progressed on a global scale. In particular, these cities are concentrated in Europe, North America and East Asia. Large quantities of resources and energy are consumed and large amounts of waste are generated in those cities.





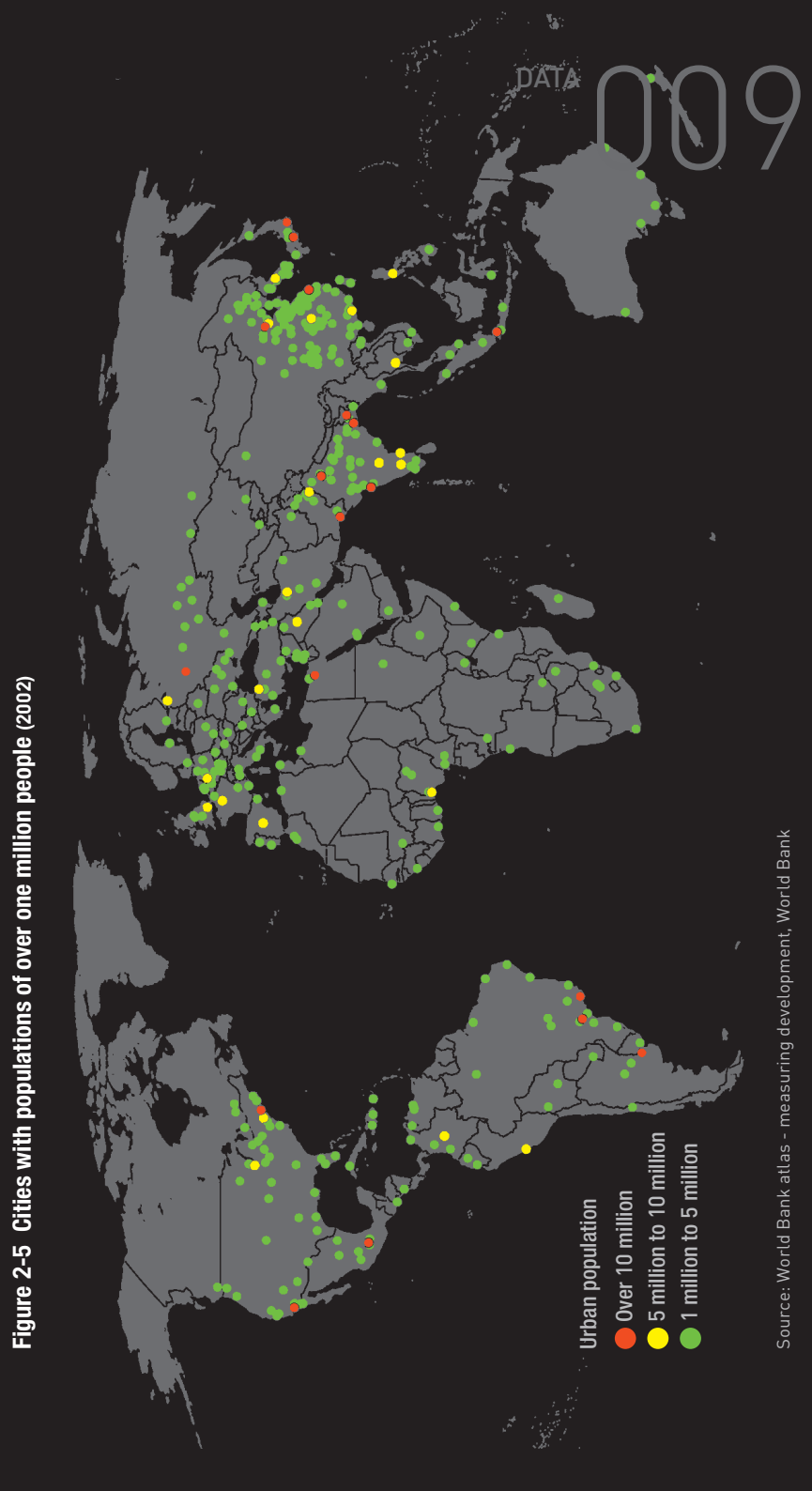



**Figure 2-5 Cities with populations of over one million people (2002)**

Changes in the ratio of urban population to world population imply that urbanization is one of the major global environmental problem humankind is facing. In particular, the increase in urban population is significant in the developing regions. This trend is more conspicuous in Asia.

DATA 010 | **Figure 2-6 Outlook for urban population by region (moderate-range estimate)**

As of 2009, nearly 50% of the world population resides in urban areas. The urban population is projected to reach almost 70% by 2050.

**Figure 2-7 Changes in the urban population percentage in Asia**

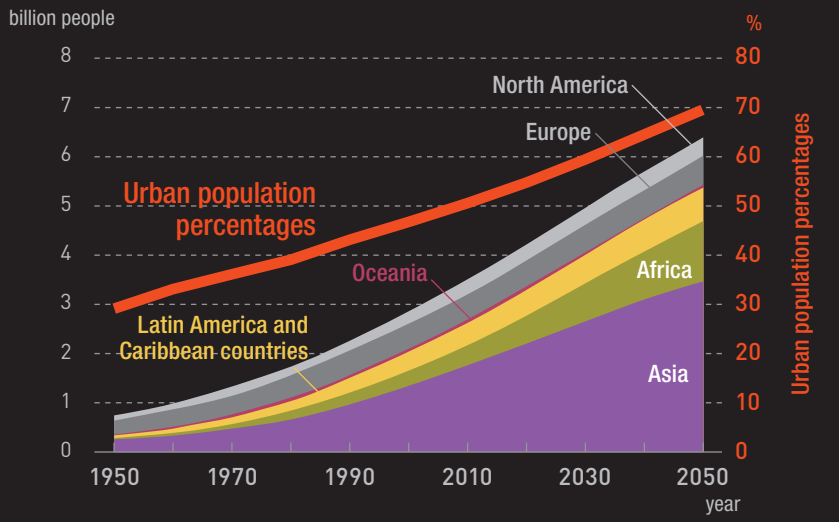
While increase in the urban population percentage has almost stabilized in Japan and South Korea from 2000 onward, it continues to increase rapidly in countries like Malaysia, the Philippines, Indonesia and China.





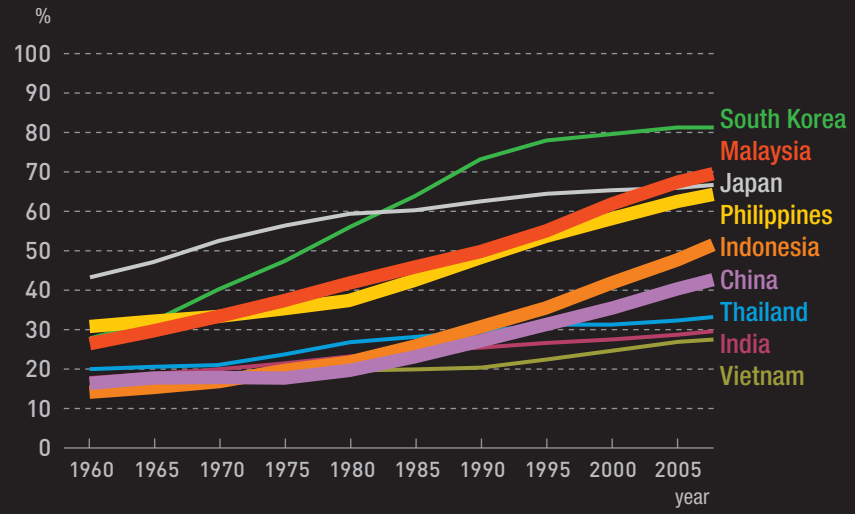


**Figure 2-6 Outlook for urban population by region (moderate-range estimate)**




Note: The definition of "urban" is based on the criteria specified by the relevant countries.
Source: World Population Prospects: The 2006 Revision, UN and World Urbanization Prospects: The 2007 Revision, UN

**Figure 2-7 Changes in the urban population percentage in Asia**




Source: World Development Indicators Online Database, World Bank

The population distribution and the regional distribution of capital ownership show how wealth is unevenly distributed worldwide. In fact, the wealth of the world accumulates on people in some limited regions.

DATA 011 | **Figure 2-8 Level of capital ownership (2000)**

As of 2000, North American countries, West European countries, Australia and Japan had the highest level of wealth (capital) per capita. Countries in Africa, South Asia and Southeast Asia lie low in that level.

**Figure 2-9 Distribution of population and capital ownership by region (2000)**

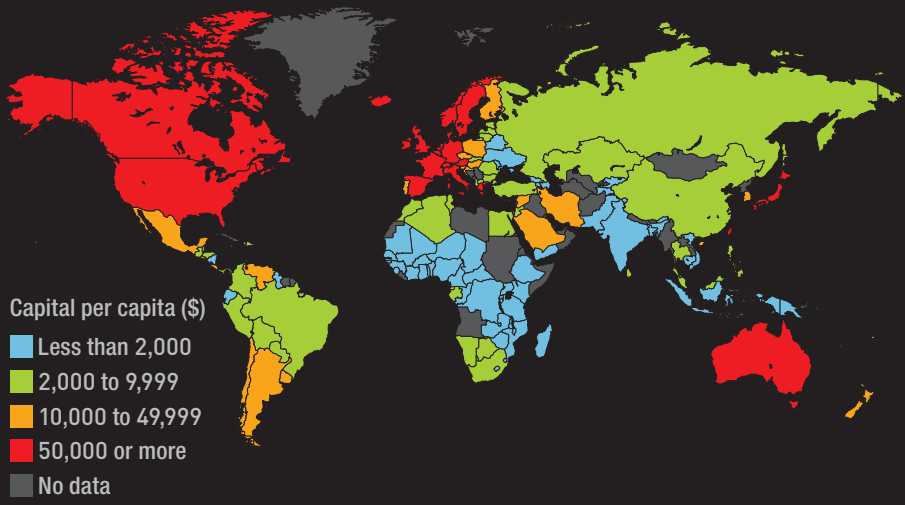
Household assets (individual assets) are concentrated in North America, Europe and high-income countries in Asia/Oceania. Nearly 88% of the total household assets in the world are concentrated in these regions. However, these regions account for only around 26% of the world population.





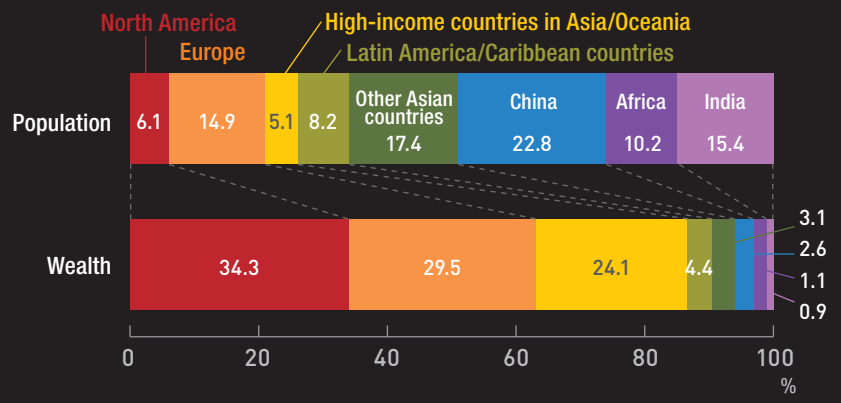


**Figure 2-8 Level of capital ownership (2000)**




Source: The World Distribution of Household Wealth, UNU-WIDER

**Figure 2-9 Distribution of population and capital ownership by region (2000)**




Source: The World Distribution of Household Wealth, UNU-WIDER

# Ⅱ Human Activities Face limitations

## Gaps in the economy and quality of life

Can the economic gap among various regions be reduced? Economic growth and size of the economy by region are shown.

DATA 012 | **Figure 2-10 Changes in GDP per capita by region (assuming the 1980 figure to be 100)**

The GDP per capita has increased significantly in East Asia/Pacific countries since 1980. The rates of increase were particularly high in the 1990s and 2000s. South Asia has also seen a rapid increase since 2000. While the GDP per capita in East Asia/Pacific countries and South Asia is increasing significantly, it remains lower than that of high-income countries and the world average (East Asia/Pacific countries: $5,013 (ppp)/person, South Asia: $2,519 (ppp)/person, high-income countries: $34,375 (ppp)/person, world average: $9,634 (ppp)/person, as of 2008).

**Figure 2-11 GDP share by region (2008)**

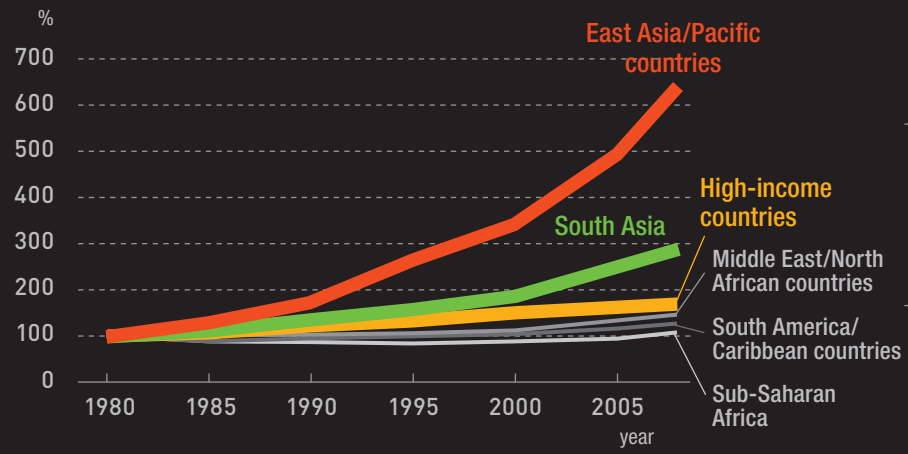
High-income countries (OECD countries and other high-income countries) produce more than half of the world GDP.





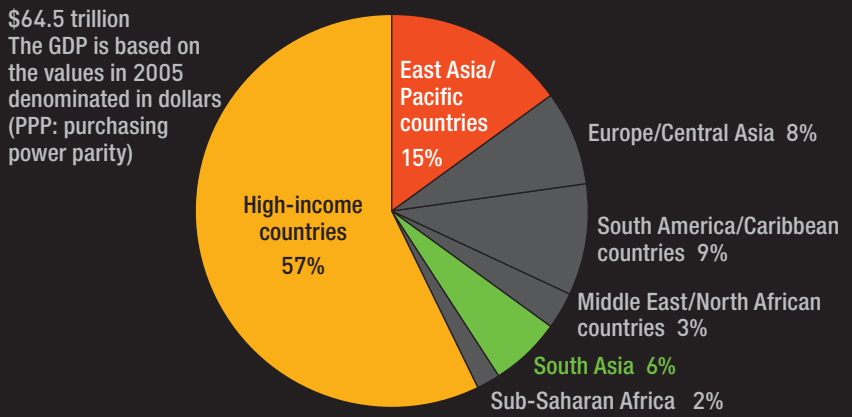


**Figure 2-10 Changes in GDP per capita by region (assuming the 1980 figure to be 100)**




* The GDP is based on values in 2005 denominated in dollars (purchase power parity conversion).
Source: World Development Indicators Online Database, World Bank

**Figure 2-11 GDP share by region (2008)**




Source: World Development Indicators Online Database, World Bank

The population of those who live on less than one dollar a day shows the status of poverty around the world. Changes in those numbers shed light on regional anti-poverty commitments and the status of economic growth.

DATA 013 | **Figure 2-12 Change in population who live on less than one dollar a day by region**

Since 1981, the population of those who live on less than one dollar a day has decreased significantly in East Asia/Pacific countries, which are regions where there has been significant economic growth. Those numbers are gradually increasing in South Asia and Sub-Saharan Africa. Worldwide, approximately one billion people, nearly 15% of the world population, lived on less than one dollar a day as of 2004. Of the one billion, South Asia accounts for nearly 48%, while Sub-Saharan Africa and East Asia/Pacific countries account for 30% and 17%, respectively.

**Figure 2-13 Change in percentage of people who live on less than one dollar a day by region (1981–2004)**

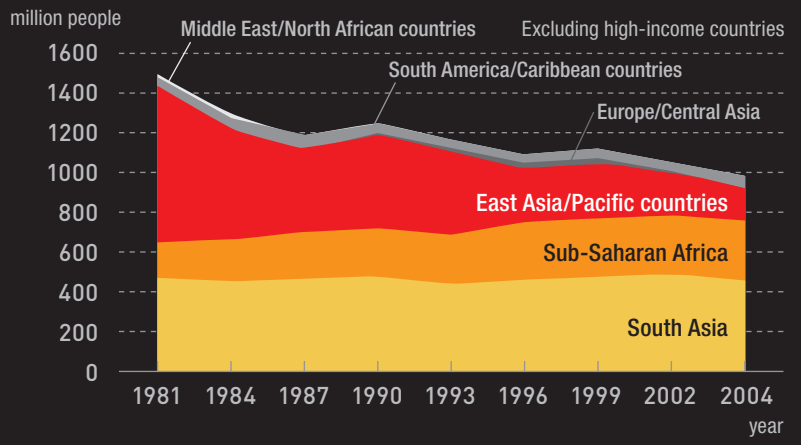
Since 1981, the percentage of people who live on less than one dollar a day have decreased significantly in East Asia/Pacific countries and South Asia. In Sub-Saharan Africa, the percentage of people who live on less than one dollar a day has never dropped below 40%. The percentage of those people in this region was higher compared to other regions as of 2004.







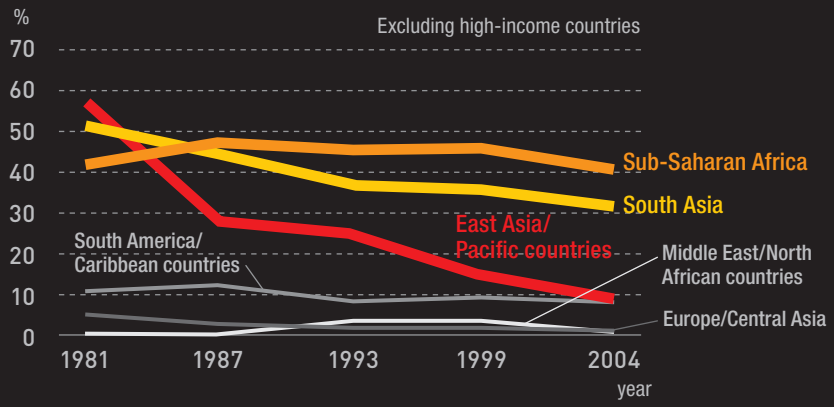
**Figure 2-12 Change in population who live on less than one dollar a day by region**




Source: World Development Indicators 2007, World Bank

2004: provisional value

**Figure 2-13 Change in percentage of people who live on less than one dollar a day by region (1981–2004)**




Source: World Development Indicators 2007, World Bank

2004: provisional value

Lifestyles in developed countries rely on the mass consumption of resources. The amount of plastics and paper consumed is shown as an example.

DATA 014 | **Figure 2-14 Consumption of plastic per capita in major countries (1995 and 2003)**

The per capita consumption of plastic, a representative petrochemical product, is high in developed countries. The amount of plastic consumed vary significantly between countries, and are increasing in most countries, with the exception of Japan.

**Figure 2-15 Consumption of paper and paperboard per capita in major countries (1995 and 2004)**

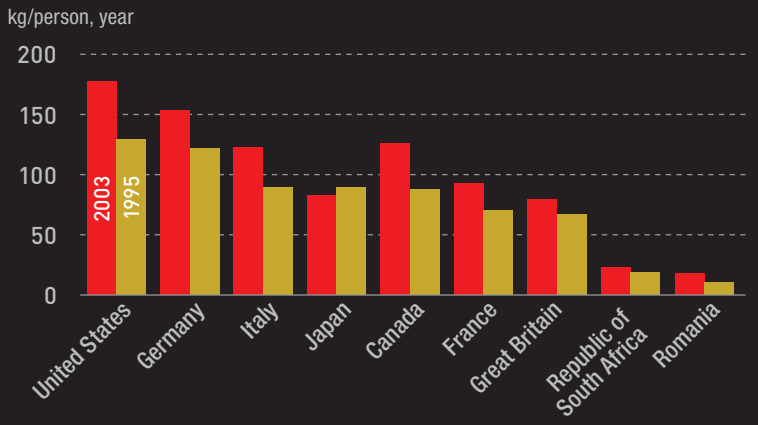
The per capita consumption of paper and paperboard is particularly high in developed countries. Among them, the United States is by far the largest consumer. A comparison of paper and paperboard consumed between 1995 and 2004 shows that while they declined in the United States and Canada, worldwide it increased. In particular, consumption has nearly doubled in China.





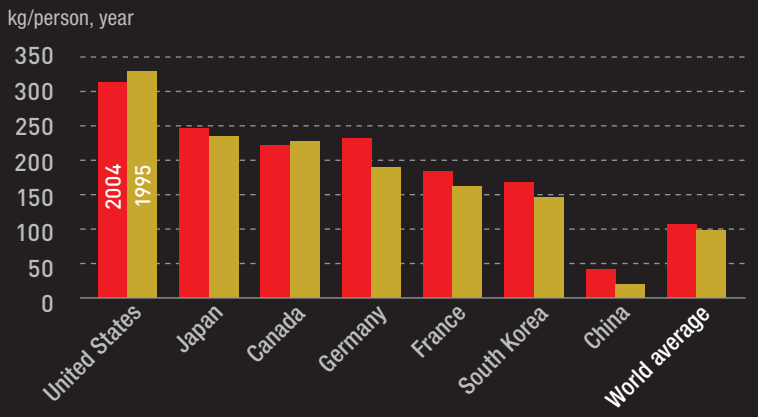


**Figure 2-14 Consumption of plastic per capita in major countries (1995 and 2003)**




Source: Data published by the Japan Plastics Industry Federation
(The data for 1995 and 2003 are excerpted from the 1997 White Paper on the Environment and the website of the Japan Plastics Industry Federation <http://www.jpif.gr.jp/2hello/conts/toukei_c.htm>, respectively)

**Figure 2-15 Consumption of paper and paperboard per capita in major countries (1995 and 2004)**




Source: Data published by the Japan Paper Association
(The data for 1995 and 2004 are excerpted from the 1997 White Paper on the Environment and the website of the Japan Paper Association <http://www.jpa.gr.jp/ja/paper/seishi/04.html in 2007>, respectively)

Motorization is spreading worldwide, most notably in developing countries. This trend is directly linked with the increase in energy consumption and significantly affects the global environment.

DATA 015 | **Figure 2-16 Outlook for annual sales of low-duty vehicles (LDVs) by region**

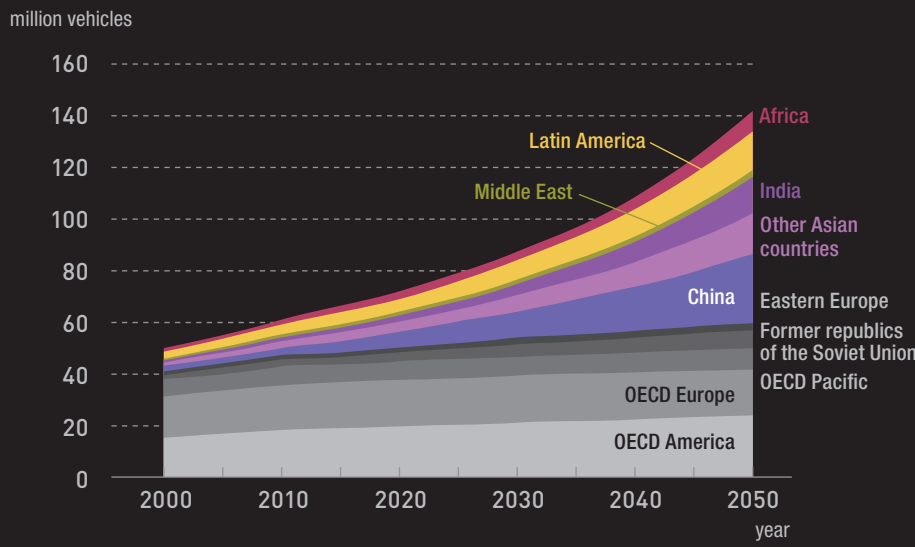
According to an estimate of annual sales of LDVs from 2000 to 2050, it is expected that while annual sales of LDVs in OECD countries will remain almost unchanged, they are projected to rapidly increase in other countries. In particular, the increase in sales will be significant in China and India. In each of these two countries, the number of LDVs projected to be sold in 2050 will be nearly 14–15 times higher than that of 2000.







**Figure 2-16 Outlook for annual sales of low-duty vehicles (LDVs) by region**




Source: Mobility 2030: Meeting the Challenges to Sustainability, WBCSD

There is a significant gap between developed countries and developing countries in terms of the spread of the Internet.

DATA 016 | **Figure 2-17 Changes in the spread of the Internet by region**

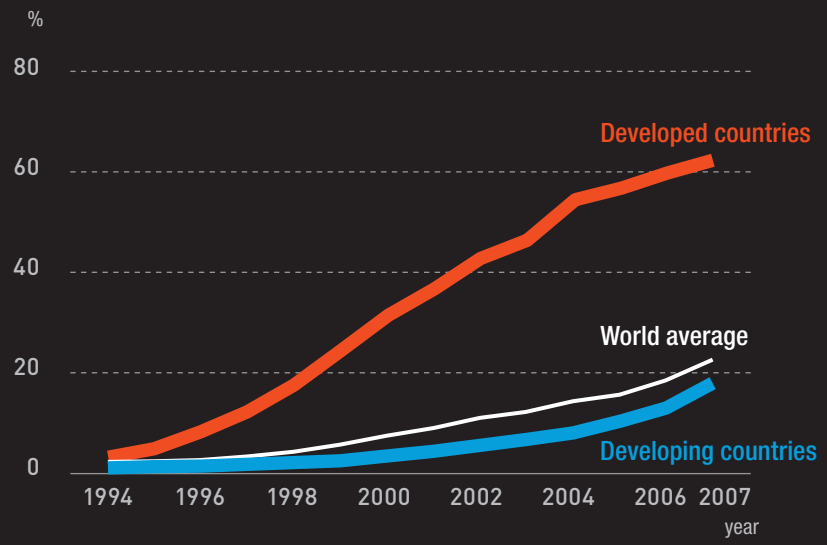
Between 1994 and 2007, the increase in the number of Internet users was far greater in developed countries. In 2007, the percentage of Internet users in those countries exceeded 60%. The percentage of Internet users in developing countries has increased rapidly since 2000. However, it was still just under 18% as of 2007, which is less than 20% of the total population of those countries.







**Figure 2-17 Changes in the spread of the Internet by region**




Source: Data published by the International Telecommunication Union (http://www.itu.int/ITU-D/ict/statistics/ict/graphs/internet.jpg)

Education is extremely important as the foundation for social development. Regional data on elementary education and literacy rates show a considerable gap in opportunities to obtain education, which should be equally available to all people. Overcoming poverty requires efforts to be made to reduce the gap. In that regard, developed countries need to provide more support.

DATA 017 | **Figure 2-18 Percentages of completed elementary education by region (1991 and 2007)**

The percentage rate of completion of elementary education increased in most regions and almost exceeded 80% in all regions except Sub-Saharan Africa, where it was around 60% as of 2007, below that of other regions.

**Figure 2-19 Literacy rate of young people (age 15–24) by region (1990, 2000 and 2007)**

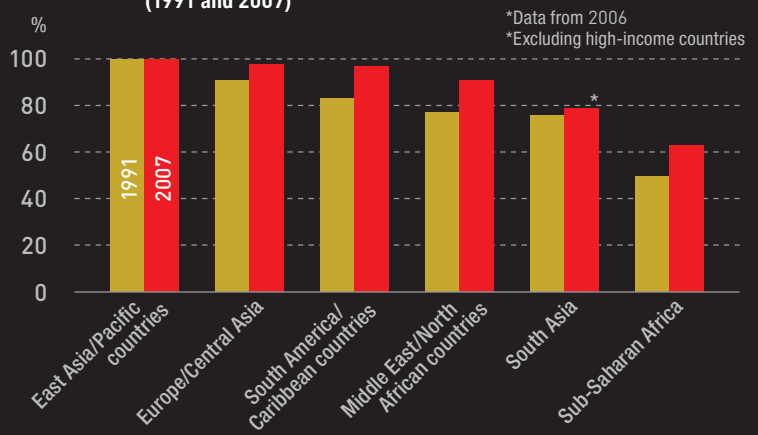
The literacy rate of young people aged 15–24 has been improving in all regions. But in the Middle East/North Africa, South Asia and Sub-Saharan Africa, the literacy rate was slightly lower than that of other regions at 60%–80%, as of 2007. Differences in the literacy rate between genders exist in those regions, but have gradually been decreasing.





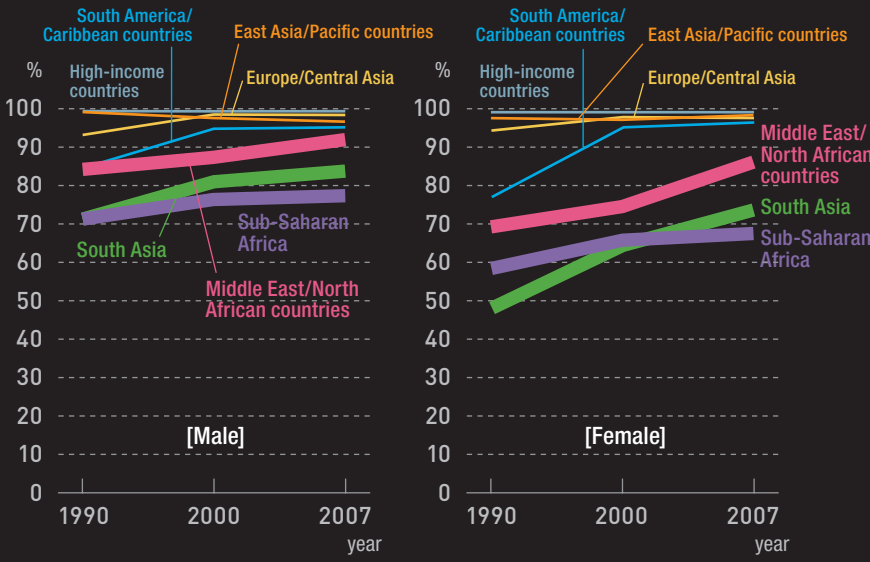


**Figure 2-18 Percentages of completed elementary education by region (1991 and 2007)**




Source: World Development Indicators Online Database, World Bank

**Figure 2-19 Literacy rate of young people (age 15–24) by region (1990, 2000 and 2007)**




Source: World Development Indicators Online Database, World Bank

The energy and mineral resources humankind consume are finite and how we utilize these valuable resources is a major challenge for us. If human activities continue as they are of today, many resources will be depleted within 100 years.

DATA 018 | **Figure 2-20 Reserves and reserves-to-production (R/P) ratio of energy resources**

The recoverable reserve is an index of the amount of proved resource reserves. It represents the amount of resources that are minable based on technological and economic conditions. As a result, recoverable reserves increase with improvements in mining technologies, the development of new oilfields, increases in resource prices etc. The R/P ratio is calculated by dividing the recoverable reserves for the year by the production amount of resources for the same year. The statistics of recoverable reserves and the R/P ratio by energy resource type show that the R/P ratio for oil and natural gas are 42 years and 60 years, respectively, and that a probable shortfall in the availability of oil and natural gas will pose a major concern by the late 21st century. The R/P ratio of coal is the longest, at 122 years.

**Figure 2-21 R/P ratios of mineral resources**

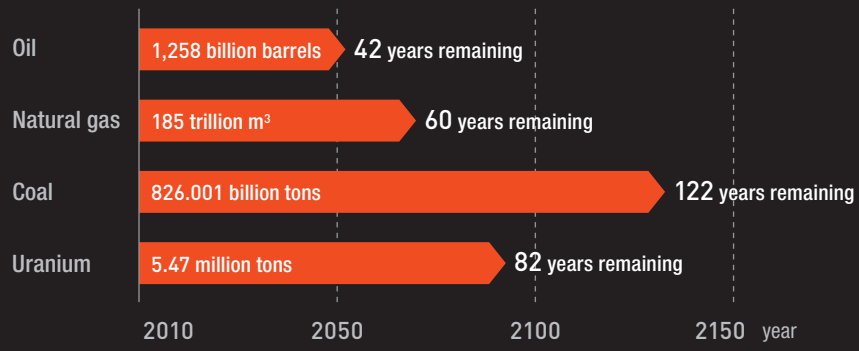
The statistics of the R/P ratios of major mineral resources (durable periods are indicated in the table) show that some of these resources are estimated to only be minable for 50 years at most. In particular, antimony, gold, indium and silver are estimated to be minable for 20 years at most. Many of the mineral resources with shorter R/P ratios are indispensable for manufacturing alloys, functional enhancement of electronic and electric appliances and improving energy-saving performances.





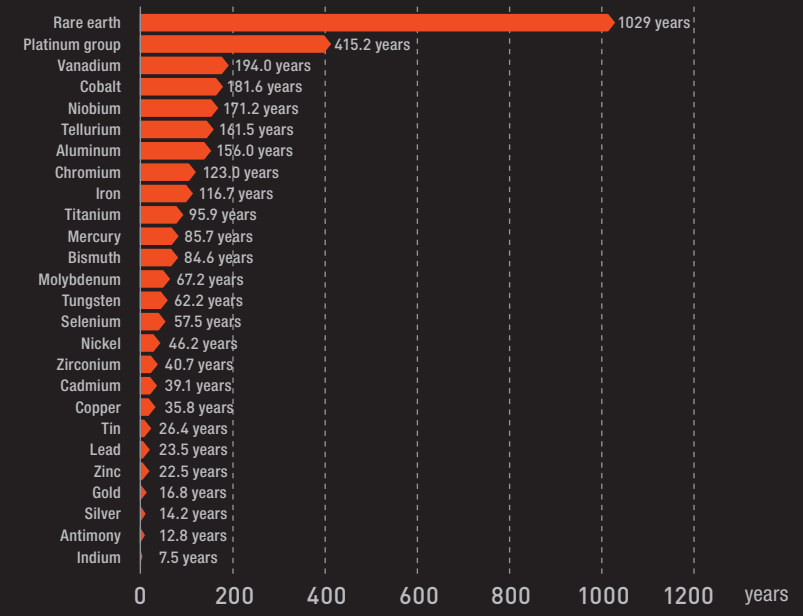


**Figure 2-20 Reserves and reserves-to-production (R/P) ratio of energy resources**




Source: Statistical Review of World Energy 2009, BP and URANIUM 2007, OECD/NEA-IAEA

**Figure 2-21 R/P ratios of mineral resources**




Source: Characterization Coefficient in the "Use of Mineral Resources" Category (March 2004), Ecomaterials Center, National Institute for Materials Science

Crude oil and liquefied gas are important energy resources, and their production is expected to decrease in the future. Humankind will be increasingly required to use these valuable energy resources more efficiently.

DATA 019 | **Figure 2-22 Changes in and prospects for the production of crude oil and liquefied gas**

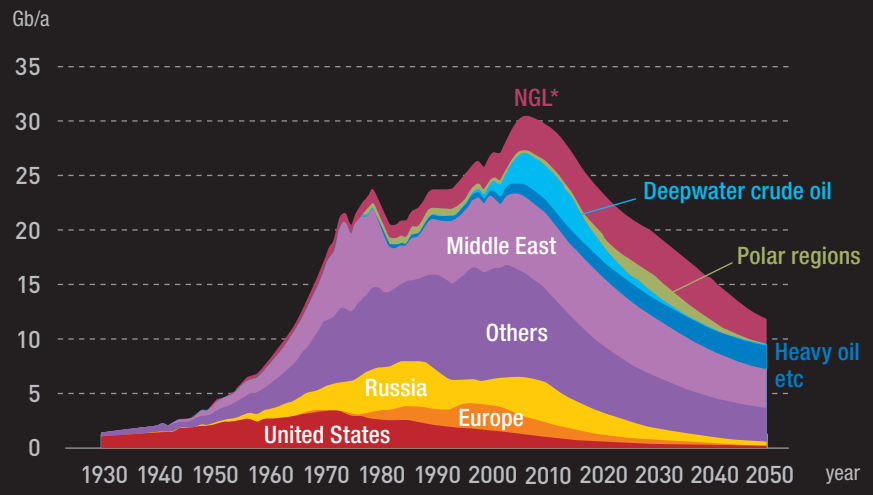
Decline in the production of crude oil and liquefied gas is expected from 2009. While the decline is significant in the United States, Europe and Russia, production will relatively remain stable in the Middle East.







**Figure 2-22 Changes in and prospects for the production of crude oil and liquefied gas**




*NGL: Natural Gas Liquid, condensate

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

The distribution of energy resources reserves differs significantly by region according to the resources. In particular, oil reserves are concentrated in only a limited number of regions.

DATA 020 | **Figure 2-23 Proven reserves of crude oil worldwide**

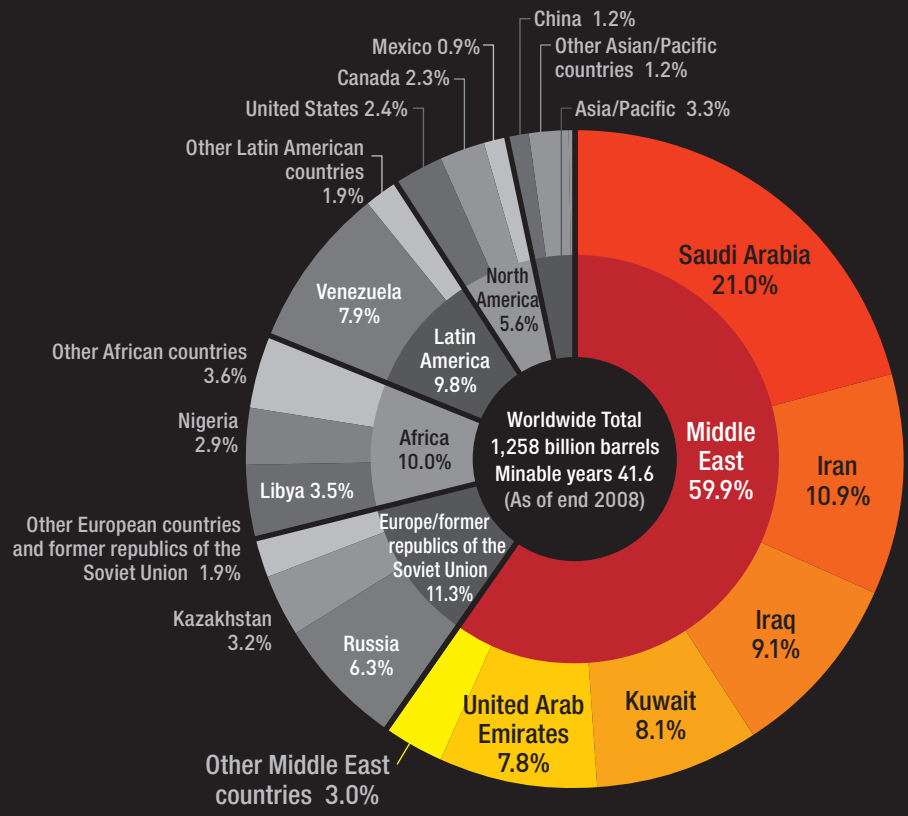
As of 2008, 1,258 billion barrels of crude oil reserves were proven to be available worldwide with Saudi Arabia having the largest proven reserves in the world. The total proven reserves for six OPEC countries which include Saudi Arabia, Iraq, the United Arab Emirates, Kuwait, Iran and Venezuela, account for nearly two-thirds of the world total.







**Figure 2-23 Proven reserves of crude oil worldwide**




Source: Statistical Review of World Energy 2009, BP

Compared to oil, the regions where coal, natural gas and uranium can be mined are spread all around the world.

DATA 021 | **Figure 2-24 Recoverable reserves of coal worldwide**

As of 2008, coal reserves that can be mined amounted to 826 billion tons globally with the United States having the largest reserve, followed by Russia, China and Australia. Coal will continue to be an important energy resource due to its superiority in terms of stability of supply and economic efficiency compared to other fossil fuels.

**Figure 2-25 Reserves of natural gas by region**

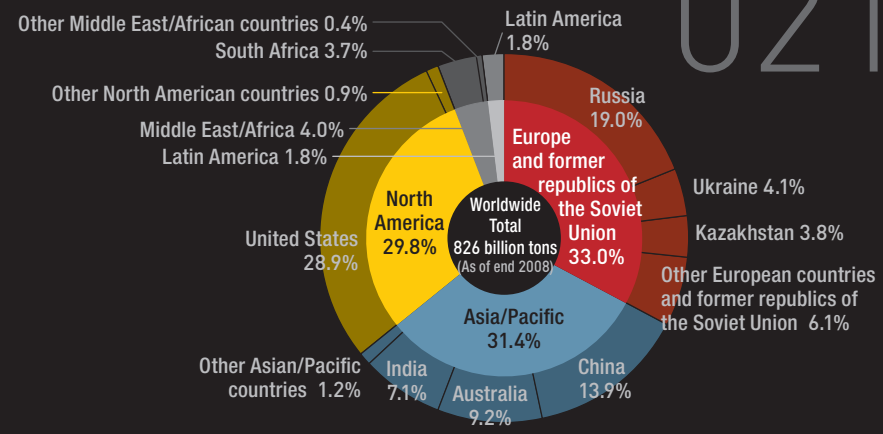
As of 2008, natural gas reserves proven to be potentially available amounted to nearly 185 trillion $m^3$ globally. Europe/former republics of the Soviet Union and the Middle East account for 34.0% and 41.0%, respectively. Reserves of natural gas are also found in Asia/Pacific, Africa, North America and Latin America.

**Figure 2-26 Amount of uranium resources worldwide**

As of 2007, uranium reserves that can be mined amounted to 5.47 million tU globally with Australia having the largest reserve accounting for 23% of the total global reserves. The reserve spreads worldwide to countries such as Kazakhstan, Russia, South Africa, Canada, the United States, Namibia, Brazil, Niger, Ukraine, Uzbekistan and others.

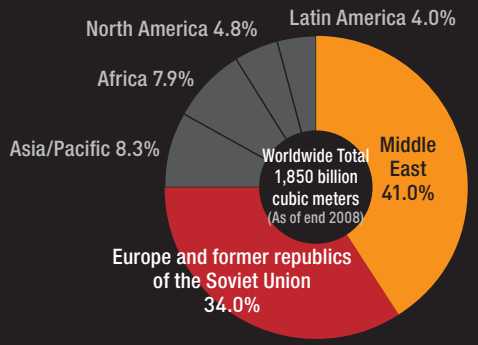


**Figure 2-24 Recoverable reserves of coal worldwide** DATA 021



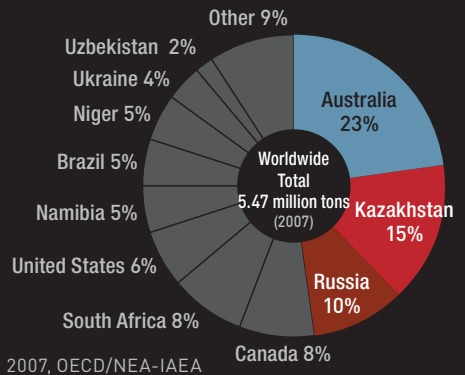

Source: Statistical Review of World Energy 2009, BP

**Figure 2-25 Reserves of natural gas by region**




Source: Statistical Review of World Energy 2009, BP

**Figure 2-26 Amount of uranium resources worldwide**




Source: URANIUM 2007, OECD/NEA-IAEA

The consumption of primary energy increases with the growth in the economy. Where will the consumption of primary energy grow most significantly in the future? This will offer an important perspective in the discussions on global environment problems.

DATA 022 | **Figure 2-27 Changes in the consumption of primary energy worldwide**

The consumption of primary energy is increasing worldwide, and it has nearly doubled in the last three decades. The increase in North America has been gradual since 1965. Up to the mid-1980s, the increase in consumption was significant in Europe/Eurasia, and after the 1990s, the increase in Asia/Pacific became significant. On the other hand, the share of OECD countries in the consumption of primary energy has continued to decline for the past 40 years.

**Figure 2-28 Changes in and prospects for the consumption of primary energy by region**

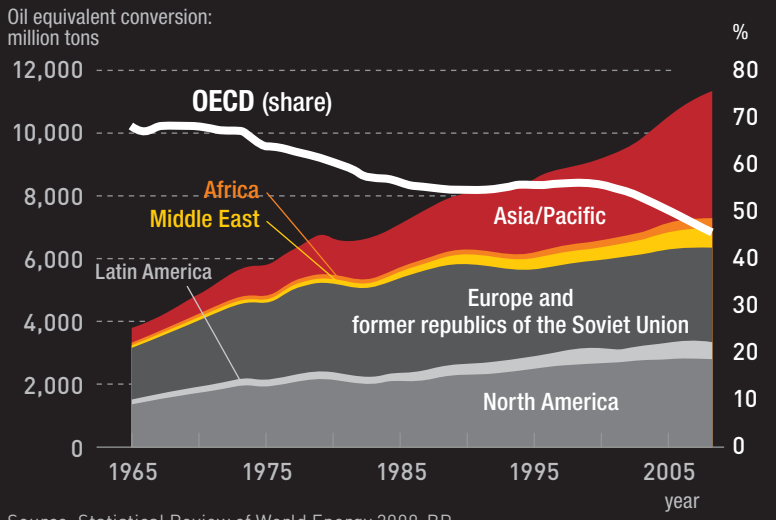
In viewing the historic trend and the prospects of the consumption of primary energy by region, it can be noted that the increase in Asia is most significant and its share in 2030 is predicted to exceed that of the OECD countries combined.





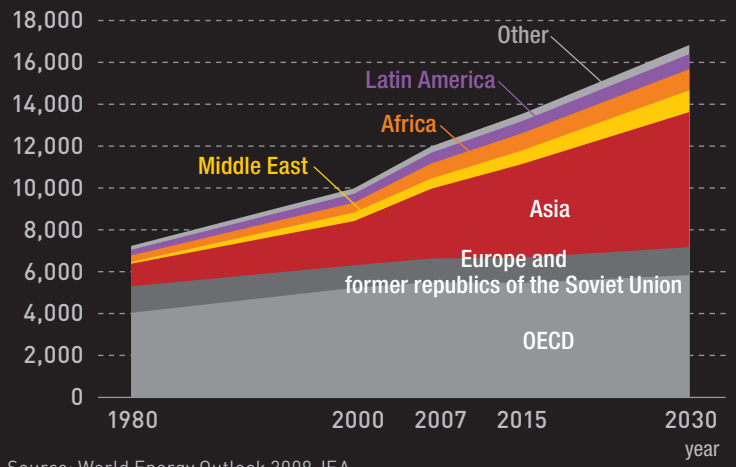


**Figure 2-27 Changes in the consumption of primary energy worldwide**




Source: Statistical Review of World Energy 2009, BP

**Figure 2-28 Changes in and prospects for the consumption of primary energy by region**




Source: World Energy Outlook 2009, IEA

Most of the energy needed for the activities conducted by humankind comes from fossil fuels such as oil, natural gas and coal. Considering the issues regarding natural resources and the global environment, it is urgently needed for us to depart from our dependence on fossil fuels.

DATA 023 | **Figure 2-29 Global energy source composition**

Oil accounted for the largest share in the global energy source composition at 46.1% in 1973, but since the use of natural gas and nuclear power increased and its share dropped to 34.0% by 2007. The share of coal and natural gas in the composition in 2007 were 26.5% and 20.9%, respectively.

**Figure 2-30 Changes in and prospects for the consumption of primary energy**

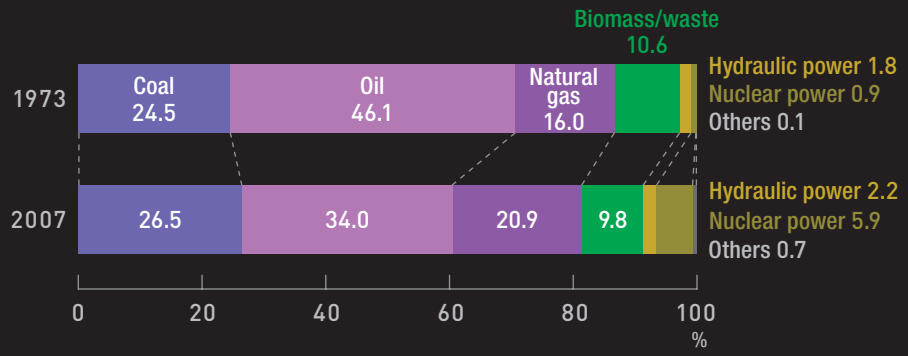
The consumption of primary energy is predicted to grow to an amount nearly 1.6 times greater than that of 2000 by 2030. Overall, the consumption of all of the energy sources will increase, with the increase in coal to be most significant which share in the global energy source composition reaching the level equal to that of oil.





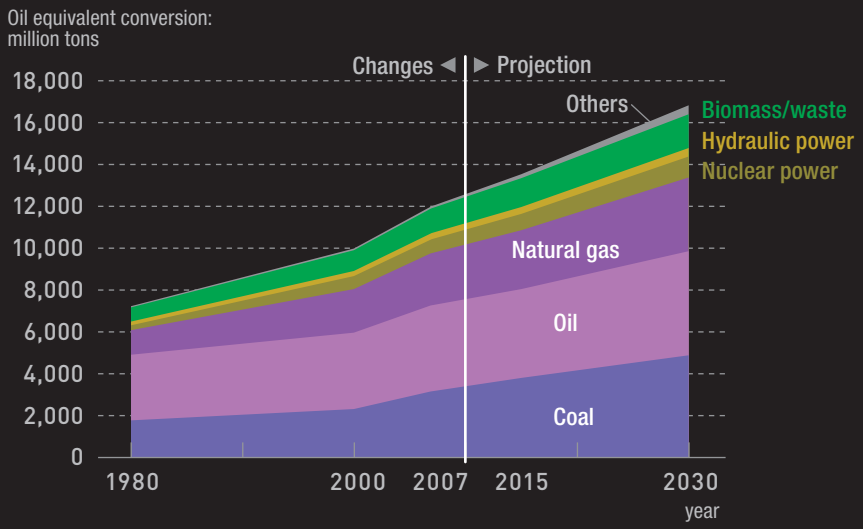


**Figure 2-29 Global energy source composition**




Source: Key World Energy Statistics 2009, IEA

**Figure 2-30 Changes in and prospects for the consumption of primary energy**




Source: World Energy Outlook 2009, IEA

Viewing the characteristics of energy consumption in different countries from a multifaceted approach, while the total energy consumption of a country depends on the size of its population and economic activity, per capita consumption is determined by the size of the economic activities and efficiency, and the consumption per GDP is often related to the efficient use of energy.

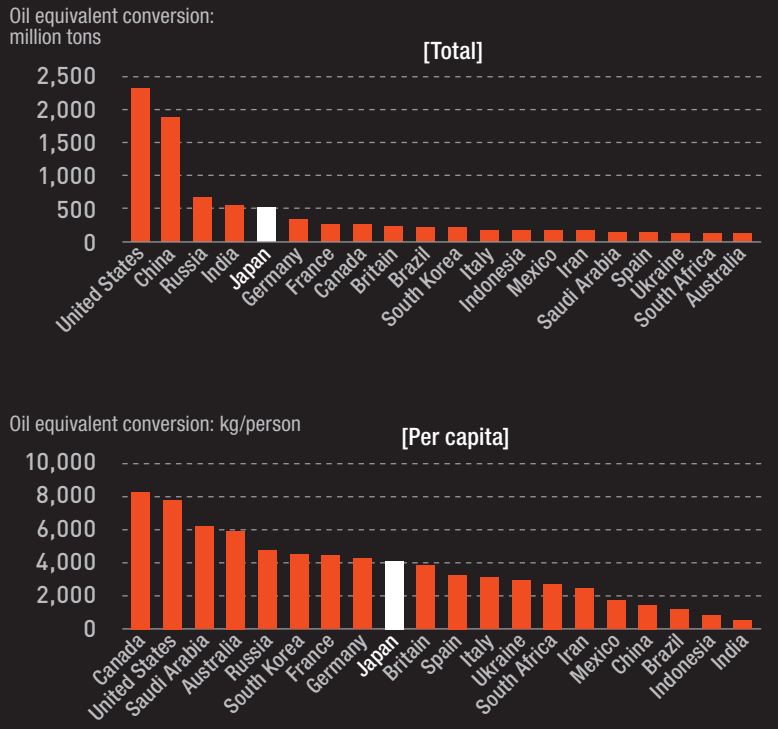
DATA 024 | **Figure 2-31 Consumption of primary energy by country (top 20 countries/2006)**

Viewing the primary energy consumption by country, in 2006, the United States was the largest consumer, followed by China, Russia, India, Japan and Germany, countries who have large population or GDP. In particular, consumption of the United States and China were huge compared to the rest. Countries with high per capita consumption were Canada, the United States, Saudi Arabia and Australia and it is necessary to change such high energy consuming economic society. Countries with high consumption per GDP are Ukraine, the Russian Federation, China, South Africa and Saudi Arabia.





**Figure 2-31 Consumption of primary energy by country (top 20 countries/2006)**




Source: World Development Indicators Online Database, World Bank

The primary energy ratios differ considerably by countries reflecting their state of affairs.

DATA 025 | **Figure 2-32 Primary energy ratios in major countries (2008)**

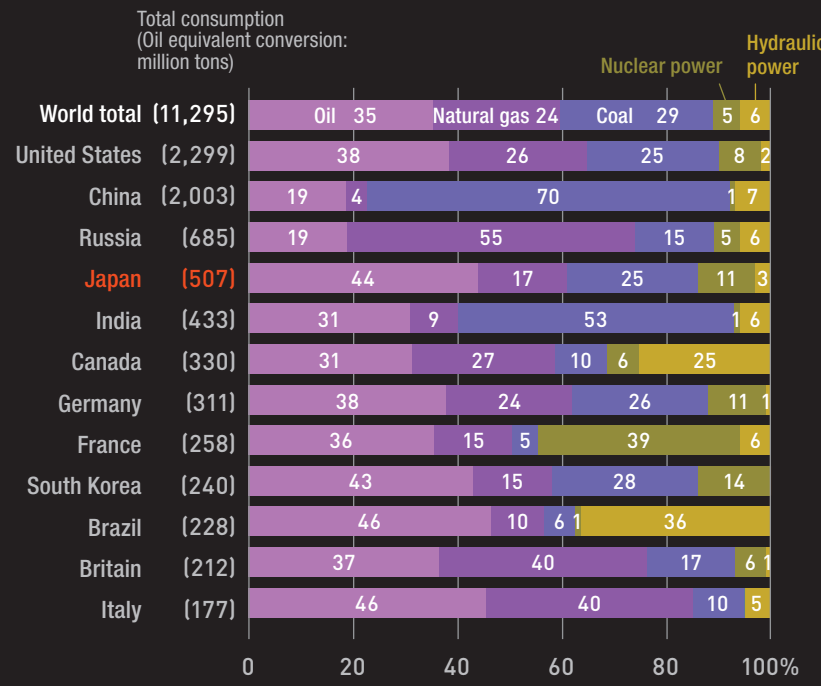
In Britain, coal formed the basis in supplying its primary energy in the past. But with the development of North Sea gas fields, dependence on natural gas has increased. France, with its limited availability of domestic energy resources, pursues a policy of proactively using nuclear power generation resulting in an extremely high ratio of nuclear power in its overall power generation. With China having abundant domestic coal resources and Russia with rich natural gas resources, they each have high ratios for them respectively.







**Figure 2-32 Primary energy ratios in major countries (2008)**




Source: Statistical Review of World Energy 2009, BP

Fossil fuels are the key energy sources in generating electricity. We need to relook into the issue from a global environmental perspective as to whether it is desirable for fossil fuel to continue to account for a large part as our energy source.

DATA 026 | **Figure 2-33 Changes in and prospects for electric power production worldwide (by source of energy)**

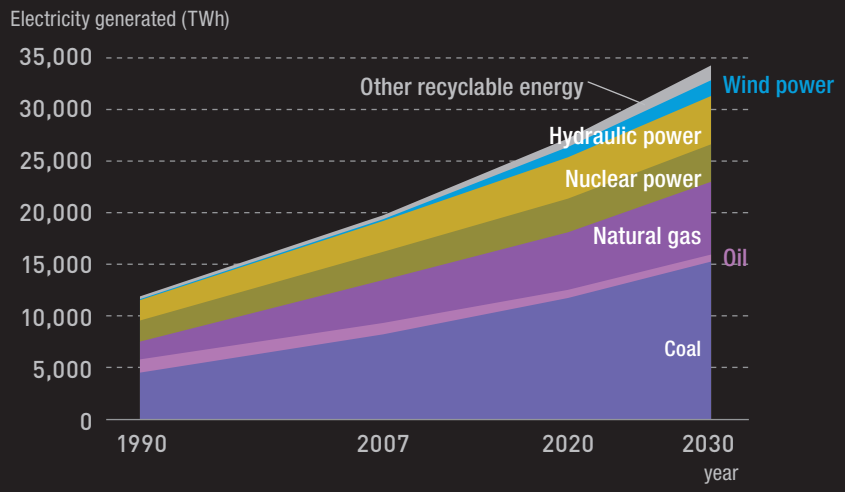
The importance of coal as the fuel for power generation is expected to increase further in the future, and the importance of natural gas is also expected to increase to a certain extent. While hydraulic power and nuclear power are continued to be used as energy sources of power generation, the importance of oil as a raw material for electricity generation is expected to decrease. Although the growth rates may be high for renewable energy sources such as wind power, the ratio of their contribution in total electricity generated is estimated to remain low even in 2030.







**Figure 2-33 Changes in and prospects for electric power production worldwide (by source of energy)**




Source: Electricity Information 2009, IEA

The changes in electric power generation are shown for those Asian countries that are expected to undergo significant economic growth. Taking the global environmental issues into account, it is important to ensure that most advanced production technologies are introduced rapidly in China and India, where electric power generation is rapidly increasing, so that $CO_2$ emissions can be reduced.

DATA 027 | **Figure 2-34 Changes in electric power generation in Asian countries**

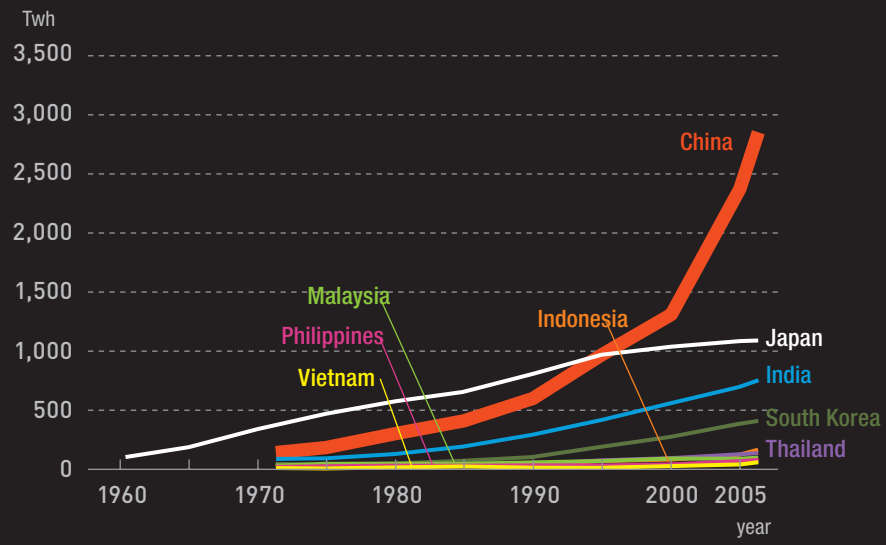
The increase in electric power generation is more significant in China than in other Asian countries. Electric power generation in China outstripped that of Japan in the first half of the 1990s, and has further made a rapid increase since 2000. South Korea and India are also experiencing an increase in electric power generation in tandem with their economic growth.







**Figure 2-34 Changes in electric power generation in Asian countries**




Source: World Development Indicators Online Database, World Bank

Which sector consumes more energy? The answer should provide data worthy of consideration in determining policies for the reduction of $CO_2$ emissions. In non-OECD countries, energy consumption in the industrial sector stands out. Ensuring the transfer of highly energy-efficient technologies to non-OECD countries would help reduce the consumption of energy dramatically.

DATA 028 | **Figure 2-35 Final energy consumption by sector in OECD countries and non-OECD countries (2004)**

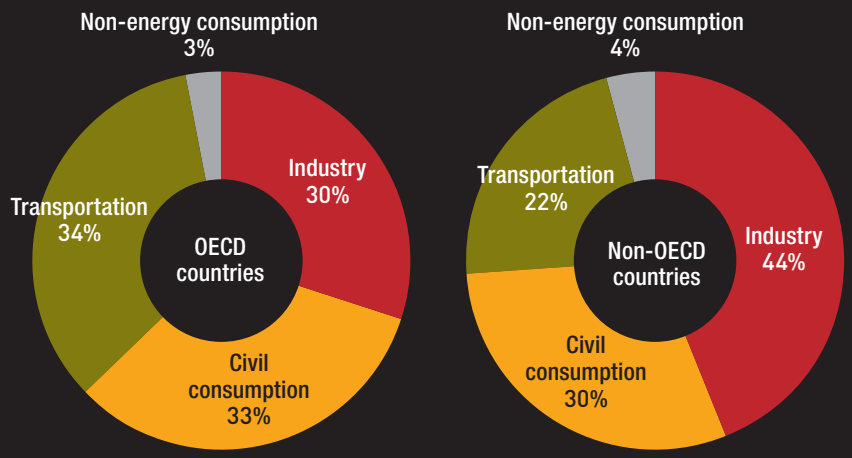
While the final energy consumption is almost equally divided among three sectors—industry, public consumption and transportation—in OECD countries, in non-OECD countries, the percentage of the industry sector is greater compared to other sectors.







**Figure 2-35 Final energy consumption by sector in OECD countries and non-OECD countries (2004)**




Source: Energy Balances of OECD/Non OECD Countries, IEA/OECD

Energy consumption per capita and electricity consumption per capita reflect the degree of economic development in the relevant region. These data are important as they relate to increased $CO_2$ emission which is suspected as the cause of global warming.

DATA 029 | **Figure 2-36 Changes in energy consumption per capita by region (1990–2006)**

Energy consumption per capita differs significantly among regions: it is nearly ten times higher in high-income countries than in South Asia, and is increasing in all regions except Europe/Central Asia. Energy consumption per capita is significantly lower in developing countries than in developed countries. It is of some concern that the economic growth in developing countries will result in a rapid increase in energy consumption.

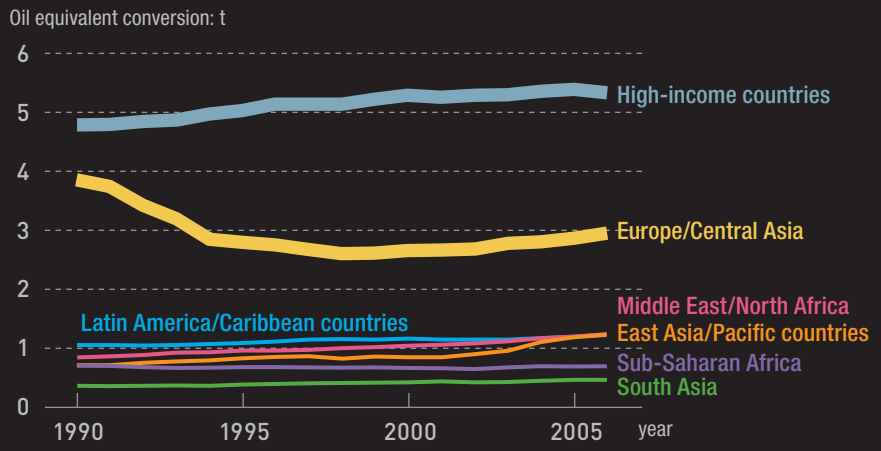
**Figure 2-37 Changes in electricity consumption per capita by region (total amount in comparison with 1971)**

Electricity consumption per capita differs significantly among regions: it is more than twenty times higher in high-income countries than in South Asia. The growth in electricity consumption per capita is significant in East Asia and Pacific countries, where consumption became ten times or more higher compared to what it was in 1971. While it is natural that the growth is lower in high-income countries and Europe/Central Asia where power supply systems are already established, low growth in Sub-Saharan Africa stands out.



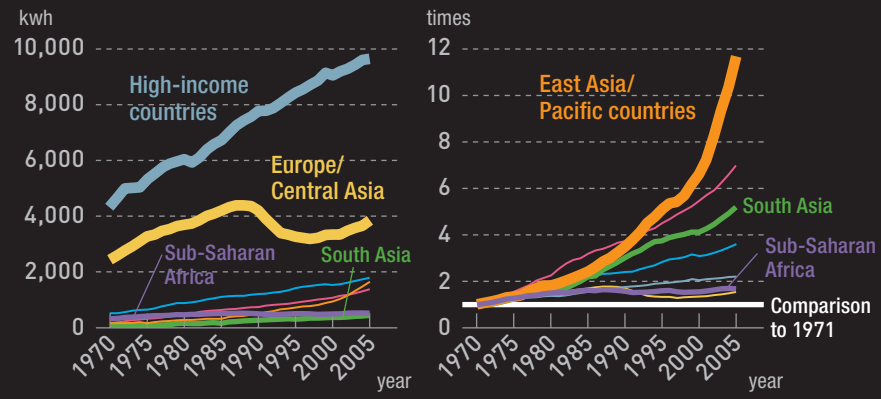


**Figure 2-36 Changes in energy consumption per capita by region (1990–2006)**




Source: World Development Indicators Online Database, World Bank

**Figure 2-37 Changes in electricity consumption per capita by region (total amount in comparison with 1971)**




Source: World Development Indicators Online Database, World Bank

Electricity is a prominent source of secondary energy in pursuing a highly convenient lifestyle and the electrification rate can be seen as a barometer suggesting the level of efficiency in lifestyle. There still remain many regions where electricity is not available and it is vital how the developed countries provide technology as well as financial resources and contribute towards solving the problem.

DATA 030 | **Figure 2-38 Electrification rate by region (1980–2006)**

Viewing the electrification rate by region, the regions having high rates are Oceania, North America and Western Europe as of 2006. Those with high growth rates when compared to 1980 are Asia, the Middle East and Latin America.

**Figure 2-39 Access to energy sources by regions**

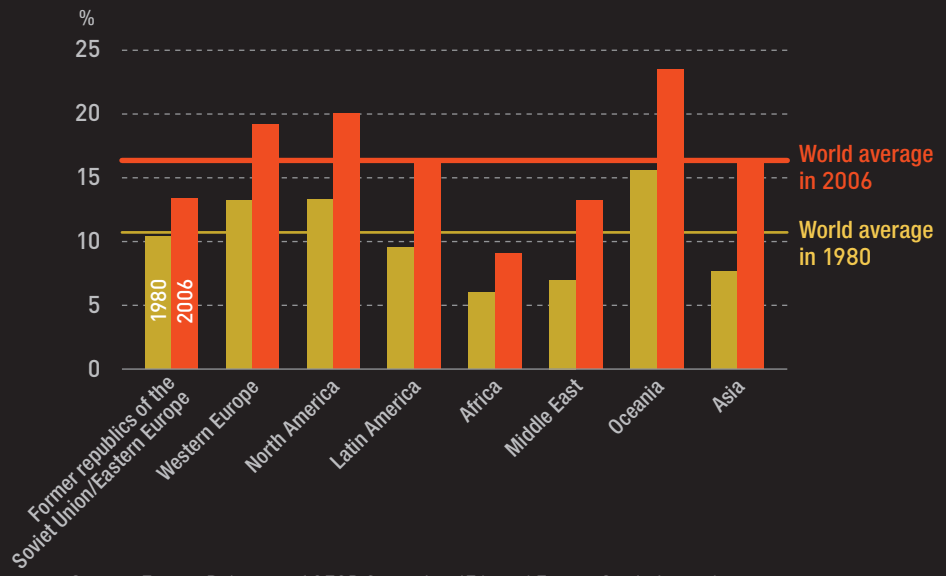
In developing countries, networks to supply electricity and gas are often insufficient. Viewing access to energy sources by region, there still exist regions with huge population without electricity in India, (Sub-Saharan) Africa, Southeast Asia and Oceania. Among the regions with huge population without electricity, there are still many that depend on non-recyclable biomass combustion which is poor in efficiency as heating source and has a significant impact on the environment. Regions those still depend on non-recyclable biomass combustion as heating source are India, China/Central Asia, (Sub-Saharan) Africa, Southeast Asia and Oceania.





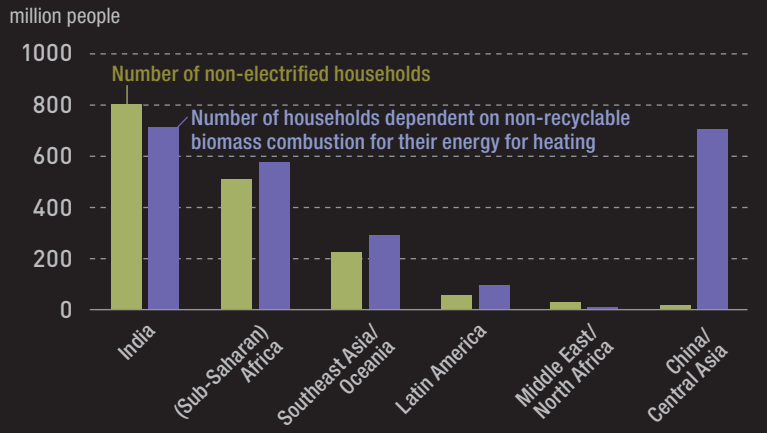


**Figure 2-38 Electrification rate by region (1980–2006)**




Source: Energy Balances of OECD Countries, IEA; and Energy Statistics and Balances of non-OECD Countries, IEA

**Figure 2-39 Access to energy sources by regions**




Source: 30 Key Trends, IEA

# Ⅱ Human Activities Face limitations

## Unevenly distributed freshwater resources

Global water resources are distributed unevenly. There exist an unbalance that while some regions find it hard even to secure the minimum amount of water required for people's survival, in some other parts large quantities of water resources are consumed.

DATA 031 | **Figure 2-40 Freshwater resources per capita (2000)**

Freshwater resources per capita differ significantly by countries and with regions. While it is abundant in the Americas, Russia and Oceania, it is scarce in North Africa. Freshwater resources are affected by not only precipitation but also by the water retention capacity of the soil, the incline, vegetation, and the degree of maintenance of water utilization facilities of rivers, and many other factors. Countries with financial reserve strength have pursued to introduce facilities for desalinating seawater in an effort to obtain freshwater from the sea.

**Figure 2-41 Amount of domestic freshwater resources per capita (by region/2008)**

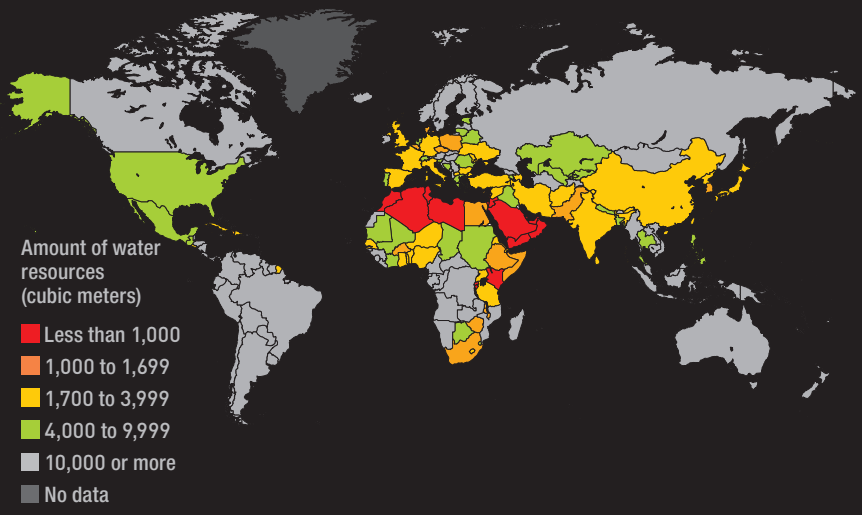
There is a huge gap of nearly 50 times in the amount of domestic freshwater resources per capita among the regions. In countries and regions with limited freshwater resources, people spend a large amount of time in fetching water, meaning that they are unable to spend much time on other productive activities.





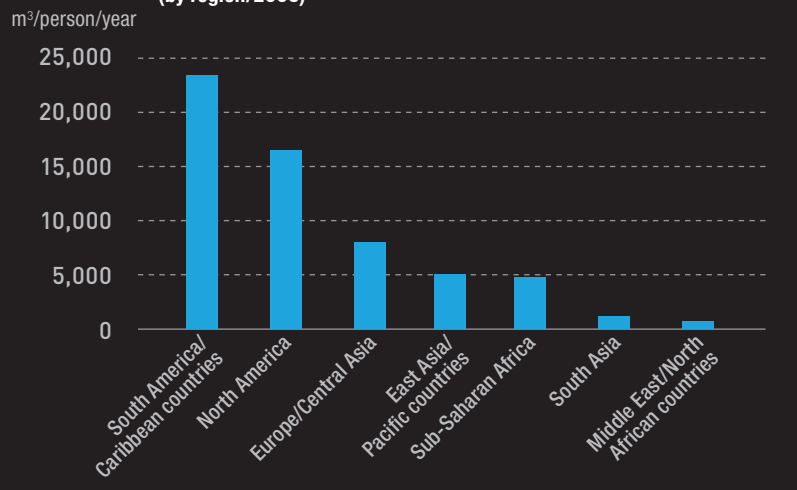


**Figure 2-40 Freshwater resources per capita (2000)**




Source: World Bank atlas - measuring development, World Bank

**Figure 2-41 Amount of domestic freshwater resources per capita (by region/2008)**




* Amount of domestic water resources: average annual river flow and amount of groundwater recharge resulting from precipitation on the territory of the relevant country

Source: AQUASTAT, FAO

The severity of water problems is expected to intensify around the world. How can countries cooperate with one another to cope with these problems?

DATA 032 | **Figure 2-42 Projection on people with water-stress and water-scarcity**

It is suspected that people with water shortage will rapidly increase due to population increase, climate change, land development and other causes. It is predicted that there would be five times more people facing water shortage in 2050 compared to 2005.

**Figure 2-43 Projection on number of people facing water shortage by region**

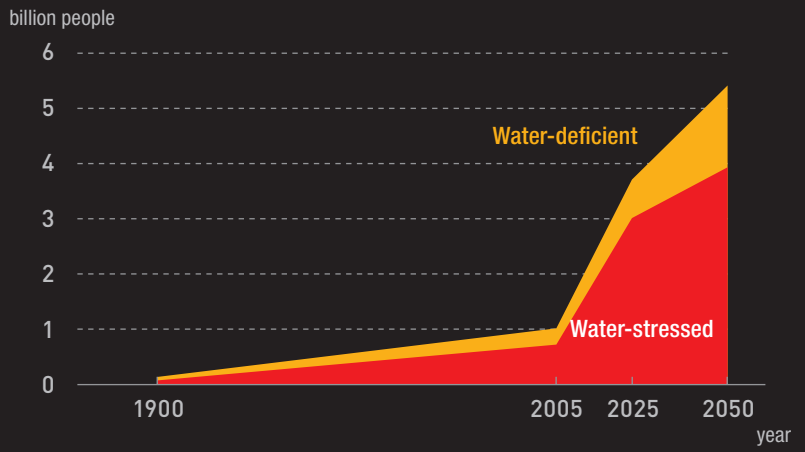
The number of people facing water shortages is particularly large in South Asia, Sub-Saharan Africa and Arab countries. The severity of water shortage problems is expected to continue to intensify.





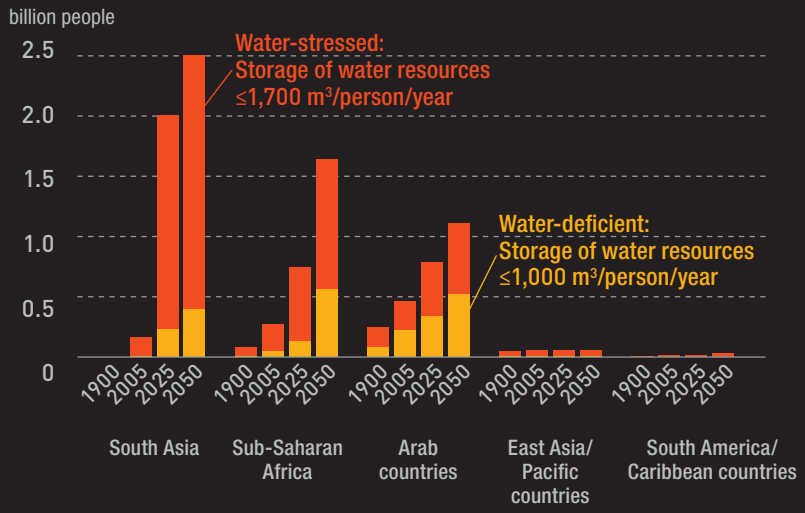


**Figure 2-42 Projection on people with water-stress and water-scarcity**




Note: "Water-stressed" and "water-deficient" mean that the annual water consumption per capita is less than 1,700 $m^3$ and less than 1,000 $m^3$, respectively.
Source: World Development Indicators 2007, World Bank

**Figure 2-43 Projection on number of people facing water shortage by region**




Source: Human Development Report 2006, UNDP

## Distribution and circulation of water

The following shows the total amount of water on Earth and the amount of water available for use by humankind. Although the amount of water available for use by humankind is very small in comparison with the total, it is sufficient for human activities.

DATA 033 | **Figure 2-44 Distribution of water resources on Earth**

Seawater accounts for most of the water resources on Earth, at 97.47%. Freshwater accounts for only 2.53%. Within this freshwater, 68.7% is contained in glaciers or other unusable form. Freshwater that can be used for agriculture, drinking and domestic use accounts for only 0.01% of the total.

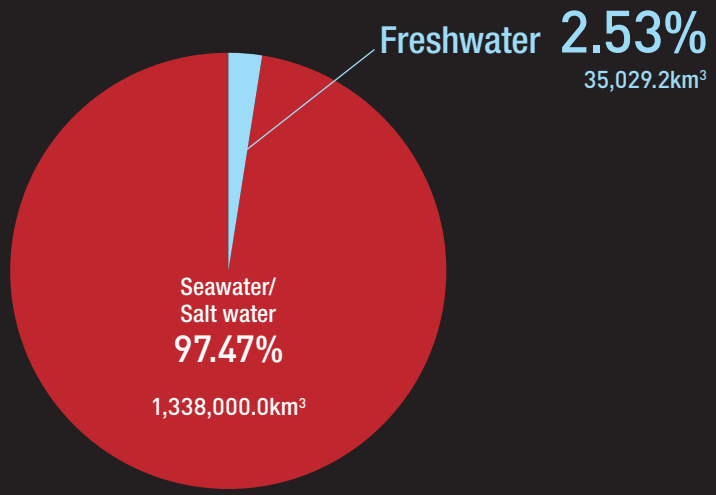






**Figure 2-44 Distribution of water resources on Earth**

| Types of water | Ratio of freshwater to total amount of water (%) |
|---|---|
| Groundwater | 0.76 |
| Water in soil | 0.001 |
| Glaciers etc. | 1.74 |
| Groundwater in permanently frozen areas | 0.022 |
| Water in lakes | 0.007 |
| Water in marshes | 0.0008 |
| Water in rivers | 0.0002 |
| Water in organisms | 0.0001 |
| Water in the air | 0.001 |




Source: Statistics on water resources in Japan in 2007, Ministry of Land, Infrastructure, Transport and Tourism
(Original text: World Water Resources at the Beginning of the 21st Century, UNESCO)

Water circulates around the earth by changing its form. Humankind and other living organisms use only a part of the water that is being circulated.

DATA 034 | **Figure 2-45 Circulation of water around the Earth**

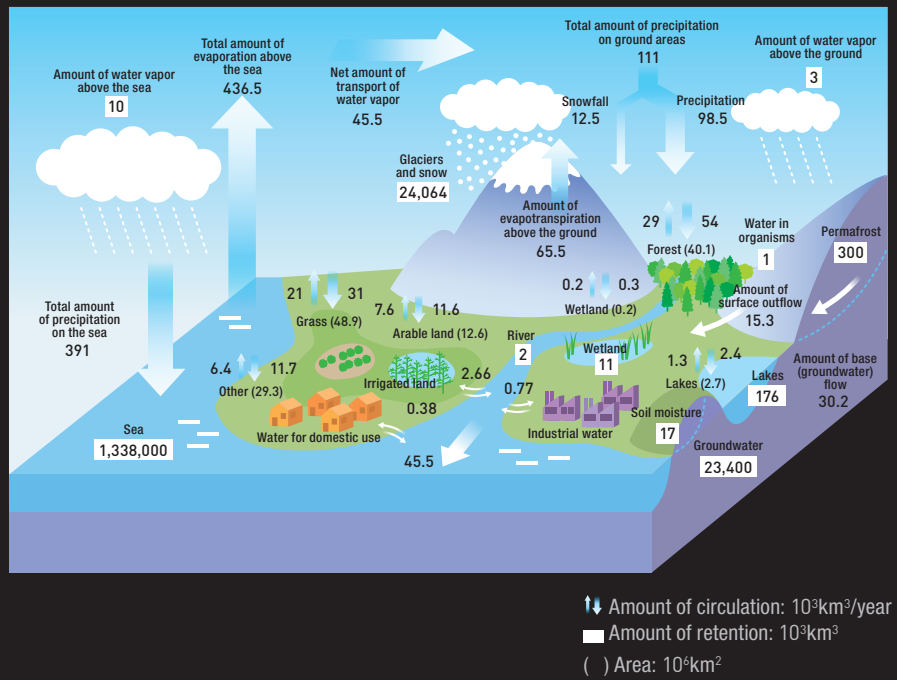
The circulation of water resources is facilitated by evapotranspiration, precipitation, surface outflow, base (groundwater) flow, river flow and other phenomena. The annual precipitation on Earth is approximately 577,000 cubic kilometers, and the annual precipitation on the ground area is approximately 119,000 cubic kilometers. Of the annual precipitation, while approx. 74,000 cubic kilometers/year evaporate again, 43,000 cubic kilometers/year flows as surface stream water and the remaining approx. 2,000 cubic kilometers/year remain underground in aquifers.







**Figure 2-45 Circulation of water around the Earth**




* The unit is 1,000km³/year. The figures in the box represent the amount of water retention (1,000km³). Figures in parentheses represent the area of land available for use (10⁶km²).

Source: the website of the Institute of Industrial Science, the University of Tokyo
(http://hydro.iis.u-tokyo.ac.jp/Info/Press200608/)
(Original text: Taikan Oki and Shinjiro Kanae: Global Hydrologic Cycle and World Water Resources, Science, Vol. 313. no. 5790, pp. 1068-1072, 2006.)

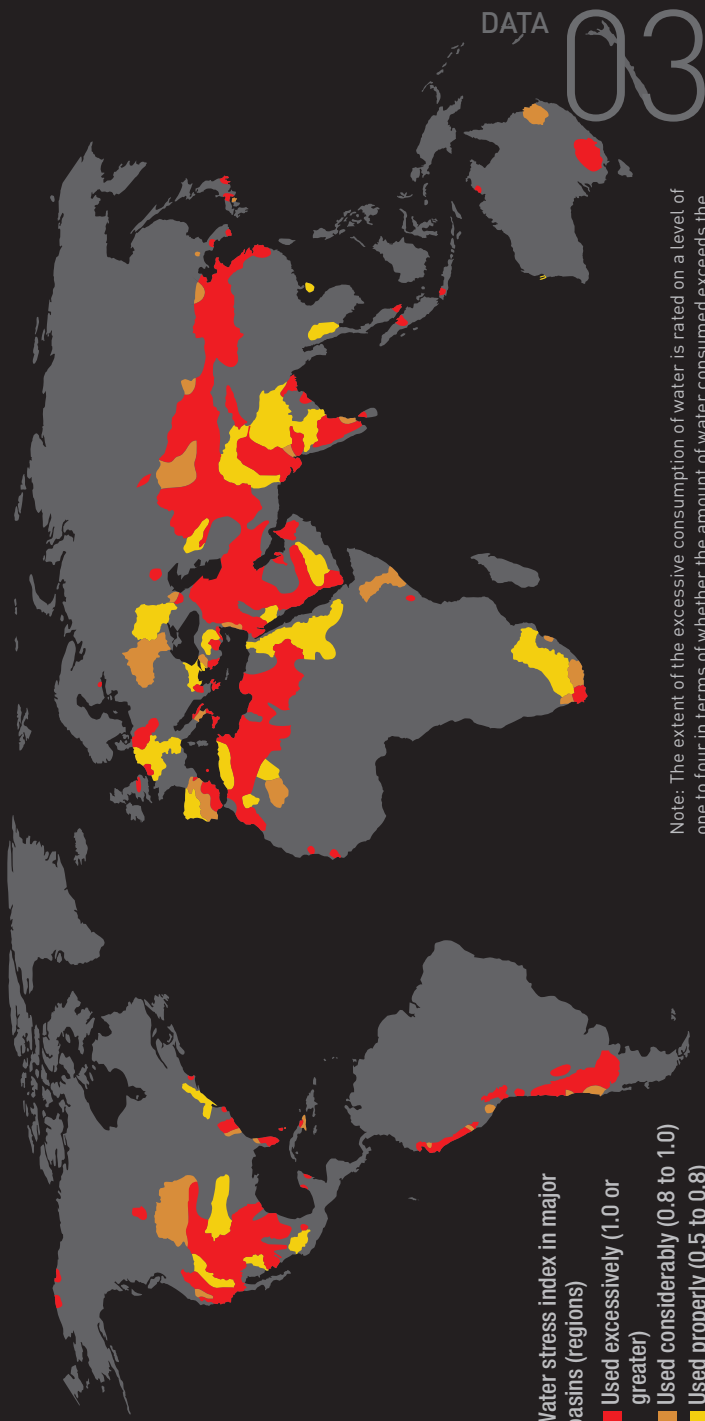
The amount of water consumption differs significantly among regions. There are still many regions where people fail to use water sustainably.

DATA 035 | **Figure 2-46 Excessive consumption of water resources**

There already are regions where the excessive consumption of water resources has made it almost impossible to secure the amount of water necessary to sustain the ecosystem. This trend is more pronounced in the mid-latitude regions of the Northern Hemisphere.








Note: The extent of the excessive consumption of water is rated on a level of one to four in terms of whether the amount of water consumed exceeds the amount of water necessary for sustaining the ecosystem.

Source: Human Development Report 2006, UNDP

**Figure 2-46 Excessive consumption of water resources**

The ratio of water resources usage differ among regions. These ratio changes significantly as the economy grows.

DATA 036 | **Figure 2-47 Water resources in the world and prospects for demand (by region and usage)**

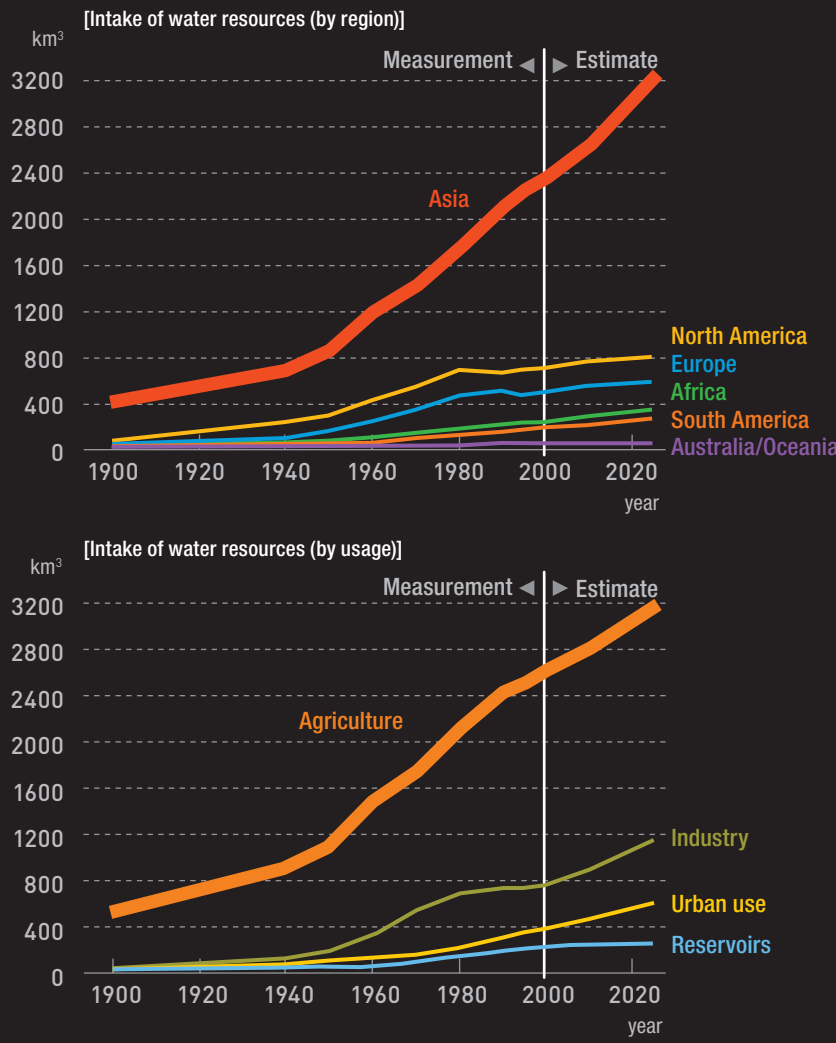
The intake of water resources is high in Asia where the population is increasing and the economy is developing. This trend is expected to continue. By usage, the ratio of agricultural use is high, and it is expected to continue to grow. It is estimated to grow by 27% by 2025 in comparison to 1995. As the amount of water consumption for industrial and domestic use expect to grow, a significant increase in demand for water is predicted worldwide.







**Figure 2-47 Water resources in the world and prospects for demand**
**(by region and usage)**




*The data from the different countries are calculated from the latest versions available.
Source: World Water Resources at the Beginning of the 21st Century, UNESCO

Water usage in high-income countries differs from other regions. It is shown that economic growth resulting from industrialization significantly influences water usage in high-income countries.

DATA 037 | **Figure 2-48 Percentages of water consumption by usage and region**

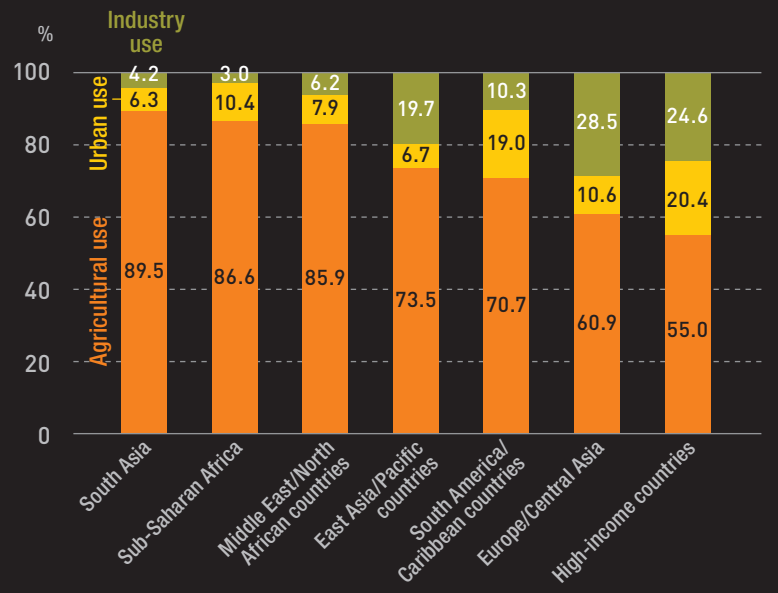
Where water is consumed varies from region to region and for high-income countries more water is used in the industry, while mid- and low-income countries use water mainly in agriculture. In Middle East/North African countries, South Asia and Sub-Saharan Africa, agriculture accounts for more than 80% of total water consumed. In case of the agricultural use of water, it should be kept in mind that there are two ways of use, one is for the production of farm products for domestic use and the other is for the production of farm products for export.







**Figure 2-48 Percentages of water consumption by usage and region**




Source: AQUASTAT, FAO

Many regions in the world still have no supply of drinking water. This is particularly serious in Sub-Saharan Africa. The technological and capital support from developed countries is highly needed.

DATA 038 | **Figure 2-49 Percentages of people supplied with drinking water (2002)**

As a major problem surrounding water it should be raised that the construction of waterworks infrastructures has not caught up with demand in many regions, except for high-income countries where almost 100% of the people are supplied with drinking water. In Sub-Saharan Africa, the percentage of people with access to drinkable water is in the range around 50%, which is significantly lower compared to other regions.

**Figure 2-50 Distribution of people who are not supplied with drinking water by region (1990 and 2004)**

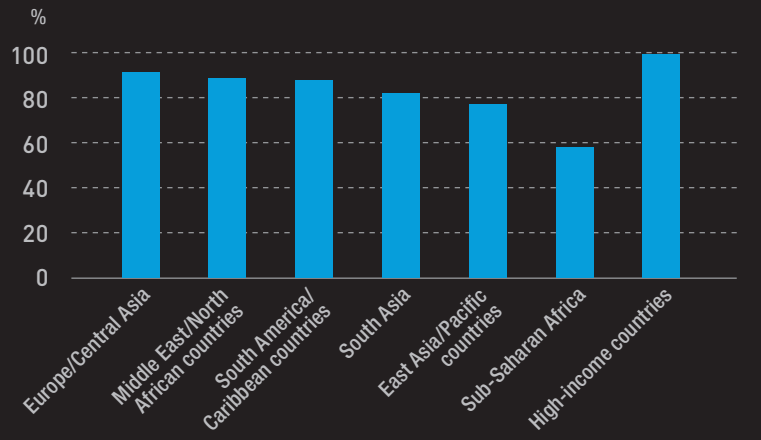
The population of those who are not supplied with drinking water is large in Sub-Saharan Africa, East Asia and South Asia. Although the number of people who are not supplied with water is declining in most regions, it is increasing in Sub-Saharan Africa.





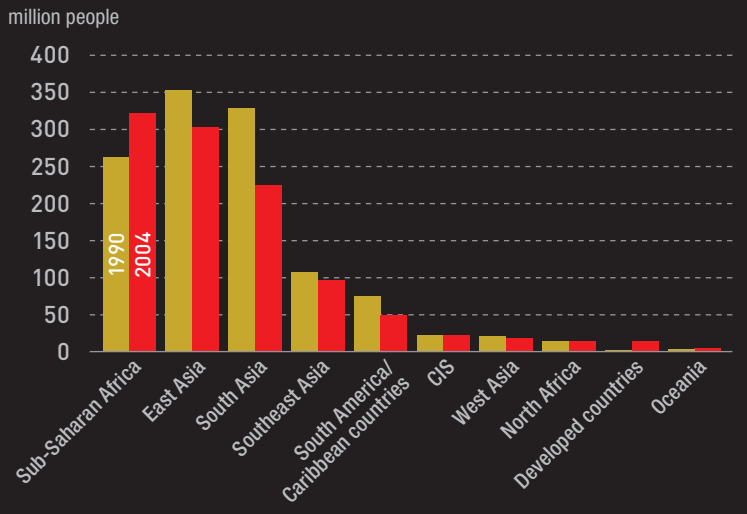


**Figure 2-49 Percentages of people supplied with drinking water (2002)**




Source: National Trends in Population, Resources, Environment and Development, UN

**Figure 2-50 Distribution of people who are not supplied with drinking water by region (1990 and 2004)**




Source: the website of the Joint Monitoring Programme for Water Supply & Sanitation, WHO & UNICEF
(http://www.wssinfo.org/en/231_wat_intro.html, Feb. 2007)

Water is a basic resource that is essential for supporting the lives of humankind.
Securing access to water is a life-or-death issue for countries and regions. This is why disputes associated to access to water breaks out constantly worldwide.

DATA 039 | **Figure 2-51 Water-related disputes around the world**

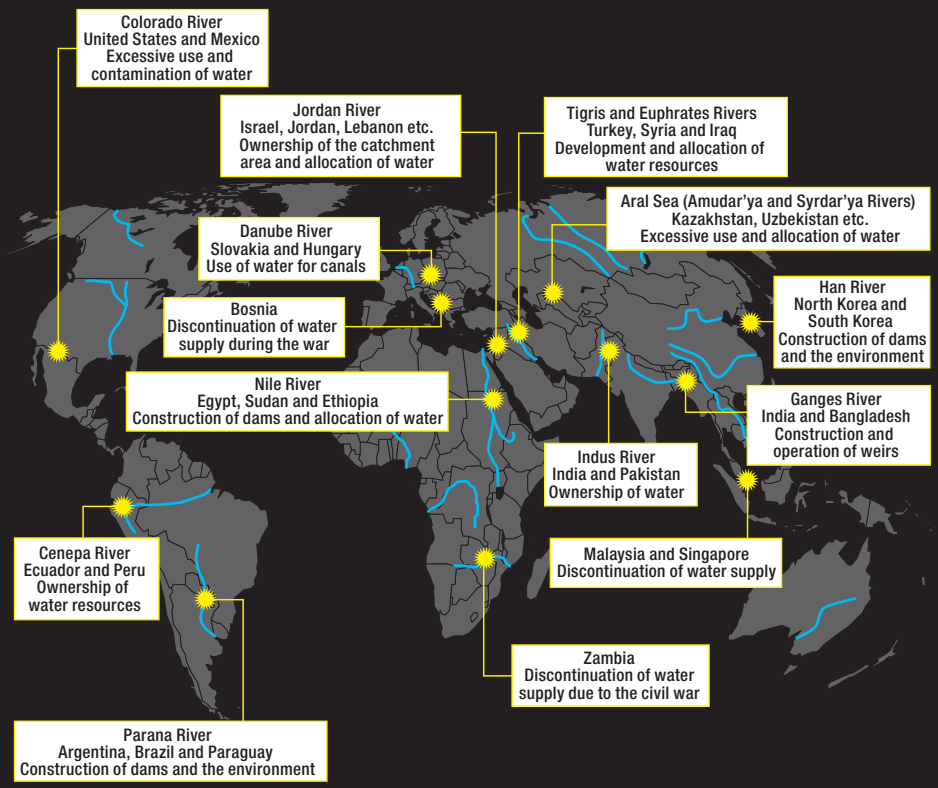
There are regions where disputes to the right of water use is occurring among countries located upstream/downstream of an international river basin. As historical circumstances have a major influence on the issues concerning the allocation of water resources, it is not so easy to solve them overnight. The reconciliation of water rights is also important for Japan, even if no international river runs through the country.







**Figure 2-51 Water-related disputes around the world**




Source: Document created by the secretariat of the 3rd World Water Forum
(Original text: The World's Water, Peter H. Gleick and Water, Marq de Villiers)

The amount of water consumption per capita per day differs significantly among countries.

DATA 040 | **Figure 2-52 Amount of urban water consumption per capita per day (2002, by country)**

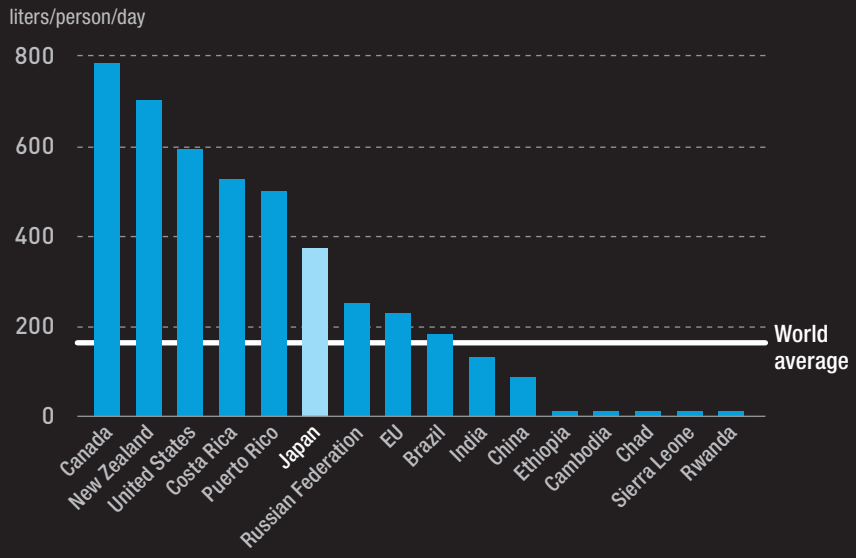
The amount of urban water consumption per capita per day is shown for the global top five and bottom five countries as well as for Japan, EU, world average and BRICs (Brazil, Russian Federation, India and China). As for the bottom five countries whose water supply infrastructures is poor, the amount provided is one tenth or less of the world average.







**Figure 2-52 Amount of urban water consumption per capita per day**
**(2002, by country)**




*The above figure shows the statistics of the top five countries, bottom five countries, Japan, EU, Brazil, Russian Federation, India, China and the world average.

Source: AQUASTAT, FAO

The amount of water consumption per capita appears to be related to the size of the economy (GDP). The amount of water consumption per capita by usage reflects the economic conditions of the relevant region.

DATA 041 | **Figure 2-53 Relationship between the amount of water consumption for industrial/domestic use per capita and GDP (2000)**

The figure shows a correlation between the use of industrial water per capita and the gross domestic product (GDP) per capita in different countries. Both the longitudinal and horizontal axes are shown in logarithmic scale. Overall, it shows that the use of industrial water increases with the increase in GDP. The countries plotted in the upper left part of the graph are oil-producing countries such as Kuwait and Saudi Arabia which are characterized as having high GDP per capita with low industrial water per capita usage.

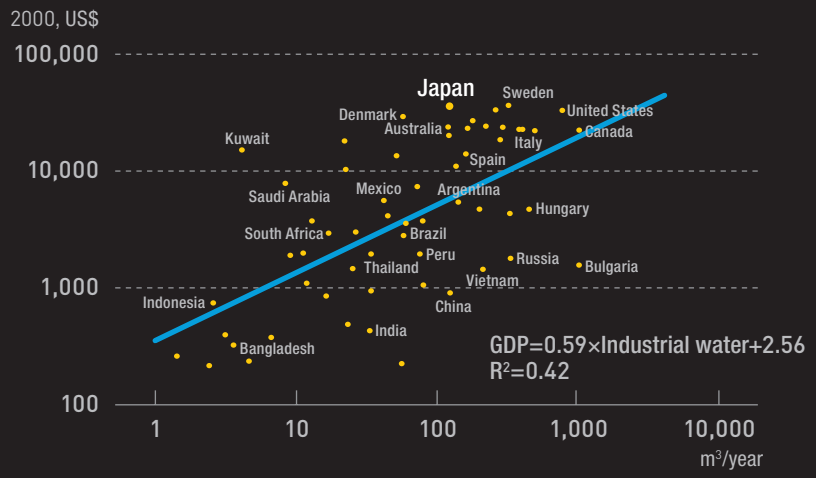
**Figure 2-54 Amount of water consumption per capita, by usage**

No clear relationship is seen in between income and the amount of water consumption per capita for agricultural use. On the other hand, the amount of urban and industrial water consumption differ significantly according to their income levels and there is a trend that the lower the income level gets the lower the water consumption become.



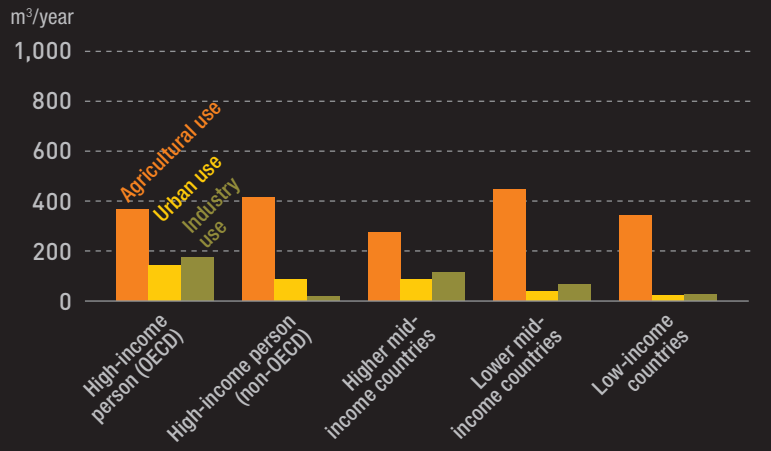


**Figure 2-53 Relationship between the amount of water consumption for industrial/domestic use per capita and GDP (2000)**




Source: AQUASTAT, FAO

**Figure 2-54 Amount of water consumption per capita, by usage**




Note: The data from the different countries are calculated from the latest versions available (2000 or later).

Source: AQUASTAT, FAO

Large amount of water is required for food production. Stockbreeding requires more water than raising crops. The relationship between food production and the amount of water consumed in the production is an important aspect in considering the water and food issues in the future.

DATA 042 | **Figure 2-55 Unit water consumption for the production of major grains and legumes**

Basic units of water consumption differ among cereal types. Rice requires the most, while corn requires only about half of the water required to produce rice.

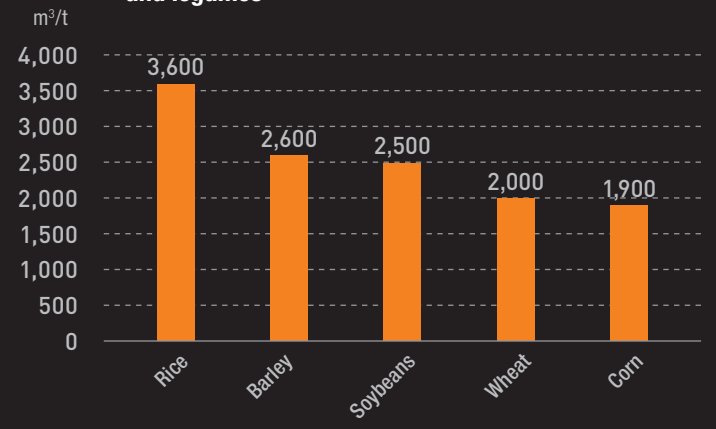
**Figure 2-56 Water required for stockbreeding**

The figure shows an estimate on the amount of water required to produce a kilogram of chicken, pork or beef, provided they were raised in Japan. Unit of water consumption for production is approximately 4,500 $m^3$/t (or 5 $m^3$/kg) for chicken, 5,900 $m^3$/t for pork and 20,700 $m^3$/t for beef. Compared to wheat production, it is about twice for chicken, about three times for pork and about ten times for beef.



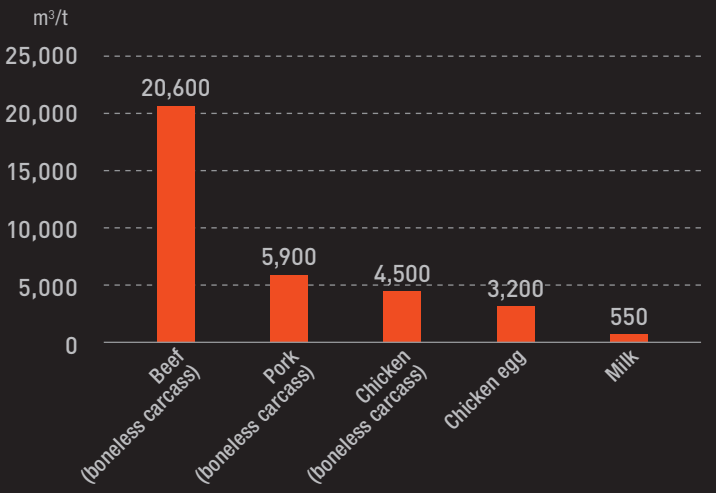


**Figure 2-55 Unit water consumption for the production of major grains and legumes**




Source: Results of a trial calculation by a group of researchers including Professor Taikan Oki from the Institute of Industrial Science, the University of Tokyo
(Calculated from the unit yield in Japan and the statistical values of FAO)

**Figure 2-56 Water required for stockbreeding**




Source: Results of a trial calculation by a group of researchers including Professor Taikan Oki from the Institute of Industrial Science, the University of Tokyo
(Calculation is based on the unit yield and breeding procedures in Japan)

Water consumption may be divided into either direct or indirect types. As a major example of indirect water consumption there is the so called virtual water, which takes into account the amount of water required for the production when importing farm products. What will be the overall water use including indirect consumption? The following is a Japanese example.

DATA 043 | **Figure 2-57 Amount of virtual water imported into Japan**

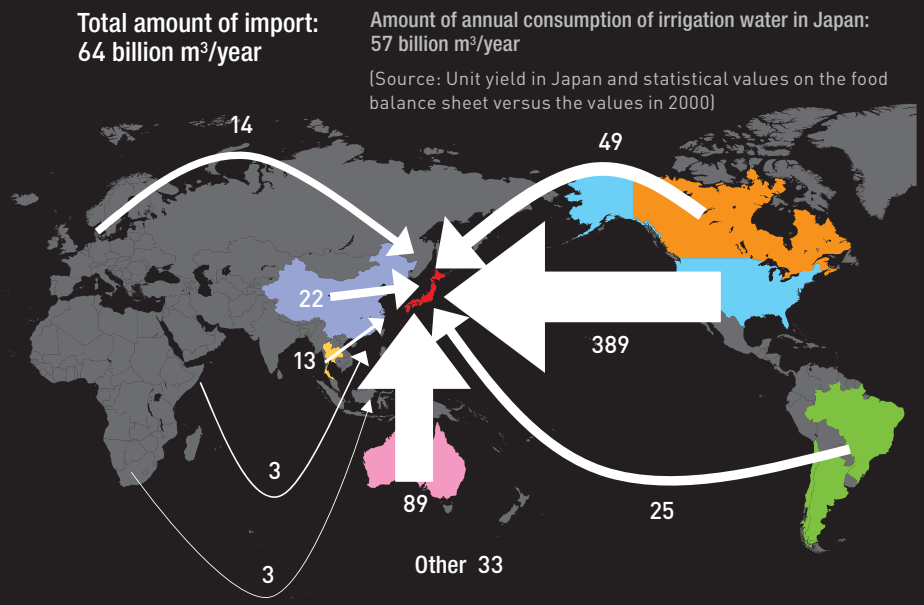
There are concepts called “virtual water” or “water footprint” which takes into account the water required for food production as being imported from the food producing country indirectly through imported food. The amount of the indirect water imported into Japan is said to be 64 billion cubic meters/year compared to the annual amount of water used in agriculture domestically in Japan of 57 billion cubic meters.
According to the aforementioned concept of virtual water, it is estimated that Japan annually imports 38.9 billion cubic meters of water from the United States and 8.9 billion cubic meters of water from Australia.



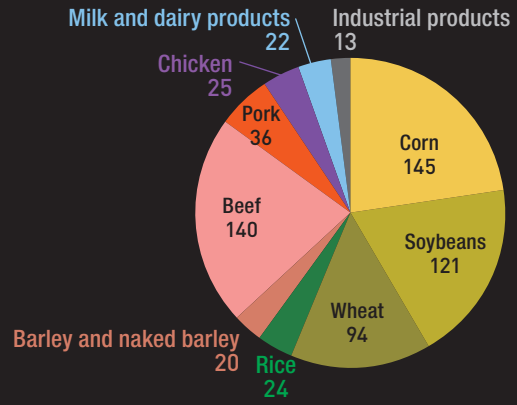




**Figure 2-57 Amount of virtual water imported into Japan**




Amount of virtual water to Japan, by item
(100 million m³/year)




Source: Results of a trial calculation by a group of researchers including Professor Taikan Oki from the Institute of Industrial Science, the University of Tokyo
(Calculated from the unit yield in Japan and the statistical values on the food balance sheet versus the values in 2000)

To support the ever-increasing population, food production must continue to increase. Humankind has expanded the area of irrigated farmland and improved food productivity. However, the area of land on earth is limited, and a drastic expansion of the land for grain production is unlikely.

DATA 044 | **Figure 2-58 Changes in the amount of grain production and the area of irrigated farmland worldwide**

The worldwide expansion of irrigated farmland has led to an increase in grain production. The area of irrigated farmland per capita shows a slight decreasing trend but this could be interpreted as the extent of the population increase to be slightly outpacing that of the expansion of irrigated farmland. As the pressure from the population increase continues to grow, further improvements in productivity and expansion of irrigated farmlands are needed. This is an important issue and may also affect biodiversity.

**Figure 2-59 Area of grain production per population of 1,000 people by region (1990–1992 and 2003–2005)**

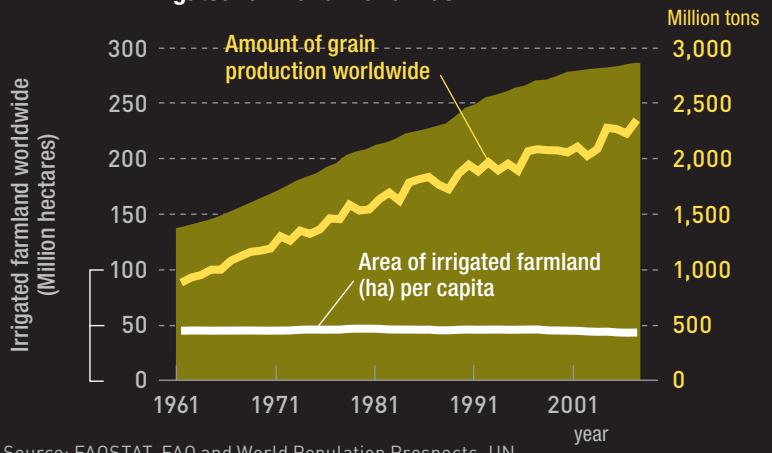
Area of grain production per population of 1,000 people is decreasing for countries with all income levels. In high-income countries, the degree of the decrease is smaller than in countries with lower income levels.





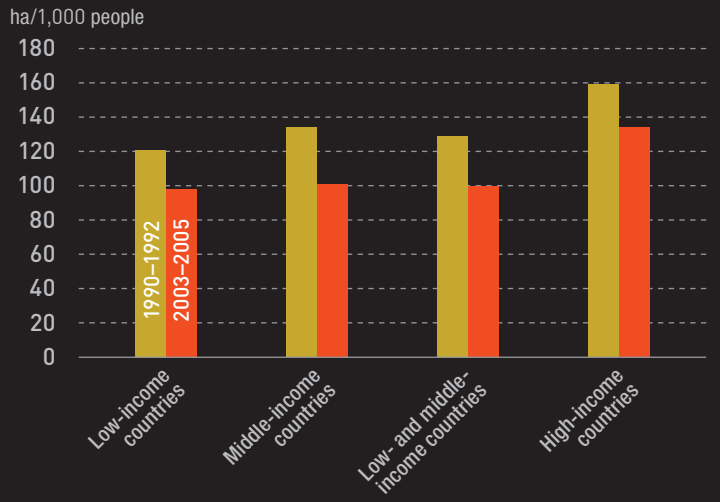


**Figure 2-58 Changes in the amount of grain production and the area of irrigated farmland worldwide**




Source: FAOSTAT, FAO and World Population Prospects, UN

**Figure 2-59 Area of grain production per population of 1,000 people by region (1990–1992 and 2003–2005)**




Source: World Development Indicators 2007, World Bank

Grain consumption is directly related to the survival of humankind and its demand will increase in proportion to the population increase in the future. The global food self-sufficiency ratio is predicted to stay at almost 100%, however, its gaps between regions are expected to widen.

DATA 045 | **Figure 2-60 Grain demand projection by region**

While grain demand in industrialized countries and countries in transition is projected to increase slightly or remain unchanged, a large increase in demand is expected in other regions, particularly in all of the developing countries including those in East Asia and South Asia.

**Figure 2-61 Grain self-sufficiency projection by region**

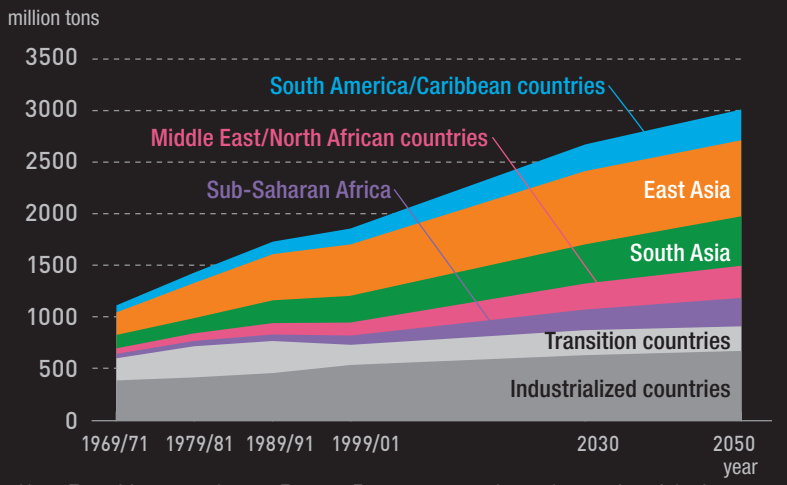
Grain self-sufficiency in industrialized countries and countries in transition is expected to rise to exceed 120% by 2030. Meanwhile, self-sufficiency is generally declining in developing countries, and is projected to fall below 60% by 2030, particularly in the Middle East/North Africa.





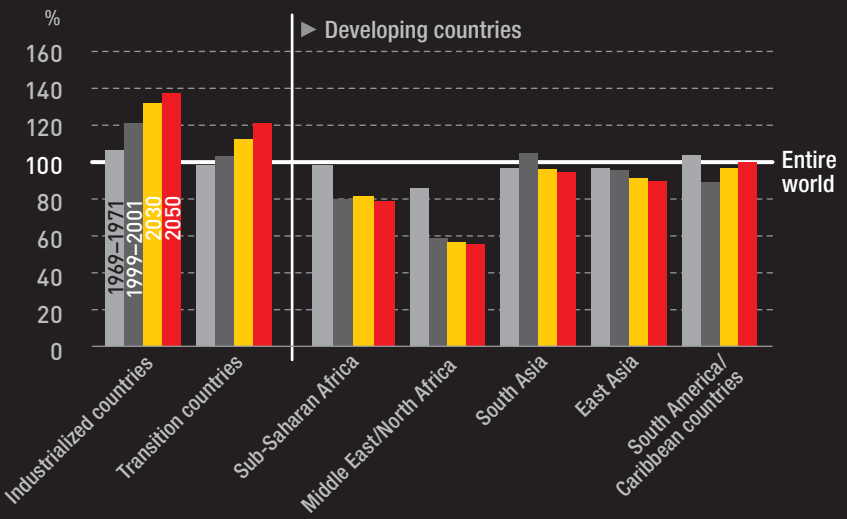


**Figure 2-60 Grain demand projection by region**




Note: Transition countries are Eastern European countries and countries of the former republics of the Soviet Union.
Source: World agriculture: towards 2030/2050 - Interim report, FAO

**Figure 2-61 Grain self-sufficiency projection by region**




Note: Transition countries are Eastern European countries and countries of the former republics of the Soviet Union.
Source: World agriculture: towards 2030/2050 - Interim report, FAO

The availability of land suitable for farming is surprisingly limited when considered globally. Various activities undertaken by humankind are increasingly leading this valuable land to deteriorate. Investigating the causes of this deterioration should provide important information in discussing how the food production in the future be.

DATA 046 | **Figure 2-62 Composition of land suitable for farming**

The land on earth that is suitable for farming without irrigation or other land improvement practices is limited, at only 11% of all the land. In the future, climate change may cause problems, even with existing arable land. For example, the incompatibility between the environment and crops may reduce the amount of land suitable for farming, thereby decreasing agricultural production.

**Figure 2-63 Area of land degradation by cause (and by region)**

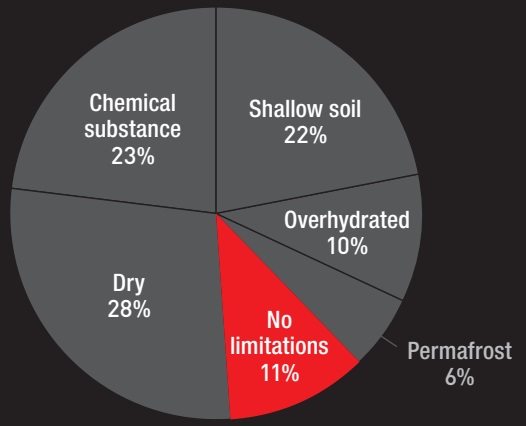
The causes of land degradation are overgrazing, deforestation and improper farm management, among others, and the area of land degraded is large in Asia and Africa. The causes of land degradation are unique to the region, and those with relatively high ratio to the regions are, deforestation for Asia and South America, overgrazing for Africa and Australia, and improper farm management for North and Latin America.





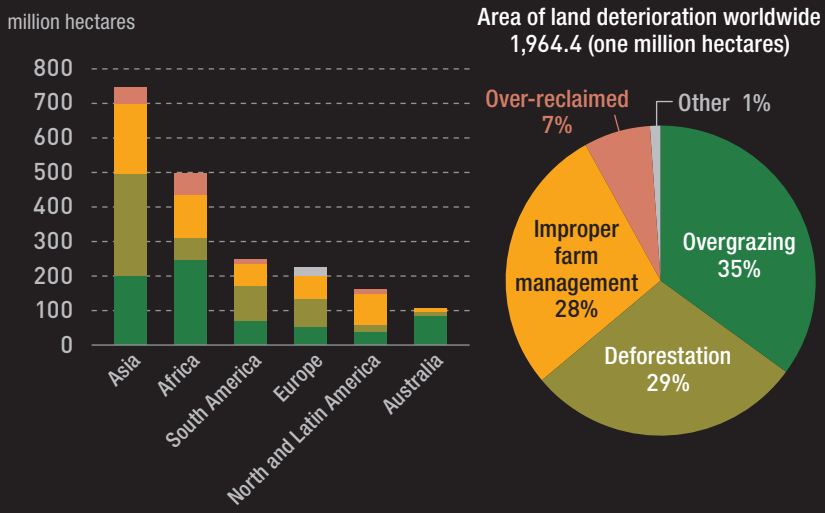


**Figure 2-62 Composition of land suitable for farming**




Source: Dimensions of need - An atlas of food and agriculture (1995), FAO

**Figure 2-63 Area of land degradation by cause (and by region)**




Source: World Map of Human-Induced Soil Degradation - An Explanatory Note (1991), ISRIC/UNEP

Various measures were undertaken to improve agricultural productivity, but they were not practiced the same in all region. The amount of fertilizer used reflects the reality of farm production worldwide by region.

DATA 047 | **Figure 2-64 Change in the number of agricultural tractors used worldwide**

The change in the number of agricultural tractors used worldwide shows that it is increasing significantly in Asia resulting in increased farm production in the region. In contrast, the number of tractors used in farming is surprisingly small in Africa.

**Figure 2-65 Amount of fertilizer used (2001)**

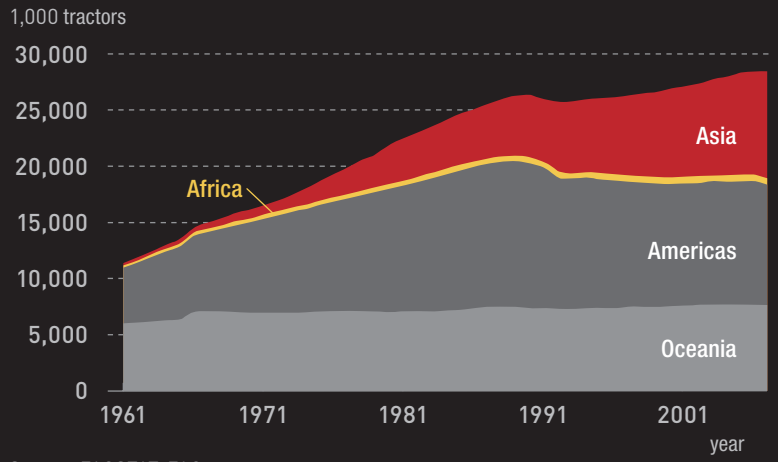
Fertilizer also can enhance productivity, but its use in developing countries remains low. On the other hand, excessive use of fertilizer may cause concern for groundwater contamination with nitrogen compounds and other hazardous substances. Consideration needs to be given to the risk of environmental pollution, as much as to the improvement of productivity.





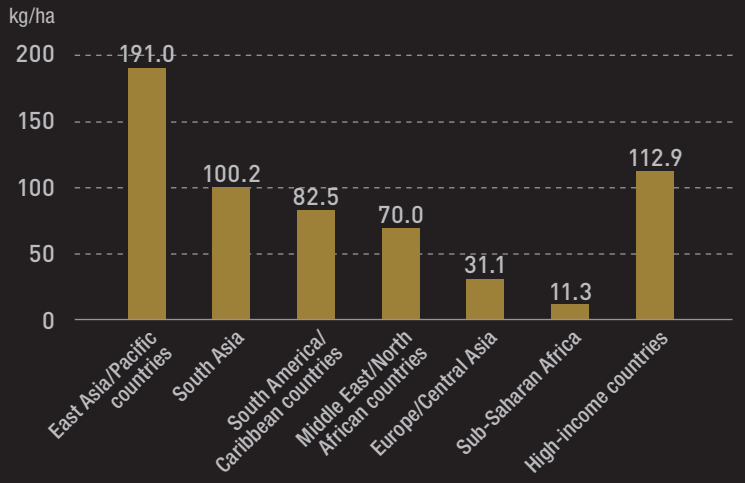


**Figure 2-64 Change in number of agricultural tractors used worldwide**




Source: FAOSTAT, FAO

**Figure 2-65 Amount of fertilizer used (2001)**




Source: Agriculture and Food Data Tables, WRI (original text: FAO, IFOAM data)

In developing countries, there are still many people who fail to take in sufficient nutrition, but fortunately, it is predicted that the calorie intake in all regions are to improve. However, there is a concern that the change in eating habits on a global scale will lead to an increase in the production of food with high environmental load (stockbreeding etc.).

DATA 048 | **Figure 2-66 Calorie supply per capita (2005)**

The average calorie supply per capita differs between regions: in high income countries it is 1.5 times larger than it is in Sub-Saharan Africa, the region with the lowest calorie supply. This index reflects the level of economy of the regions. While malnutrition is the major problem in developing countries, lifestyle-related diseases and other illnesses resulting from excessive intake of calories are the major concern in developed countries.

**Figure 2-67 Calorie consumption per capita change and future projection**

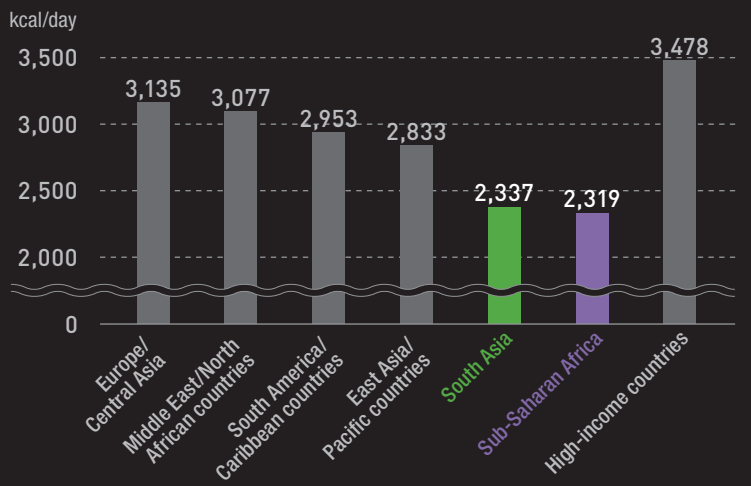
Calorie consumption per capita is increasing and the trend is expected to continue. Currently, people in some regions, such as Sub-Saharan Africa, are exposed to chronic insufficient nutrition due to poverty and other factors. This situation is expected to improve to some extent. Meanwhile, excessive intake of calories has become a major problem mostly in developed countries.





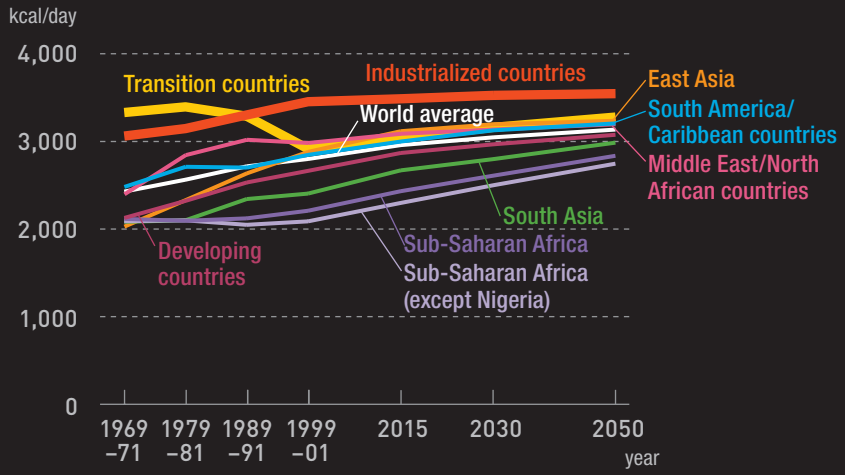


**Figure 2-66 Calorie supply per capita (2005)**




Source: FAOSTAT, FAO

**Figure 2-67 Calorie consumption per capita change and future projection**




Source: World agriculture: towards 2030/2050 - Interim report, FAO

Children and infants who have low tolerance to disease continue to fall victim because of insufficient food supply, unsanitary water, limited availability of healthcare services and other poverty-related problems, as well as conflicts and disasters.

DATA 049 | **Figure 2-68 Projection on malnourished infants (aged five and under) by region (1997 and 2020)**

The number of malnourished infants is expected to decrease in all regions except Sub-Saharan Africa, where it is projected to further increase.

**Figure 2-69 Infant (children aged five and under) mortality (2002)**

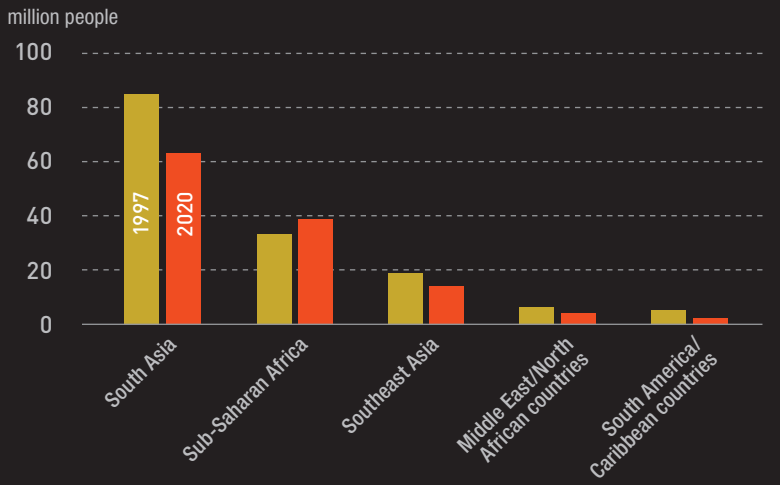
Infant mortality is extremely low in high-income countries. In contrast, it remains high in Africa and South Asia because of poverty-related malnutrition, poor hygiene, and low inoculation rate for vaccinations.





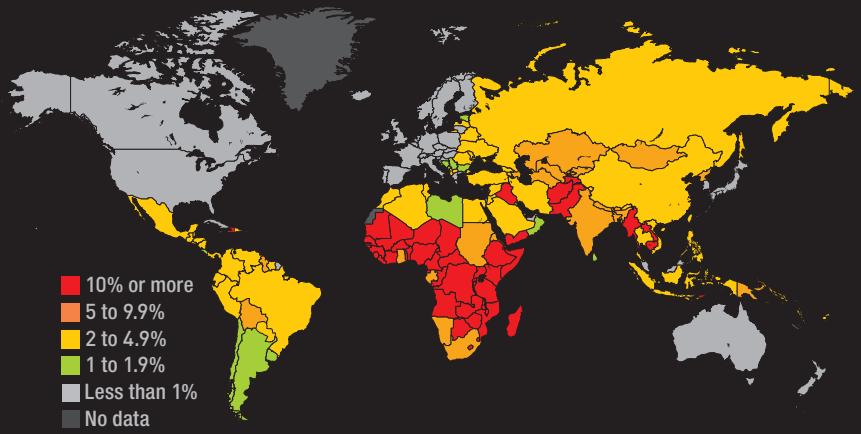


**Figure 2-68 Projection on malnourished infants (aged five and under) by region (1997 and 2020)**




Source: World Development Indicators 2006, World Bank

**Figure 2-69 Infant (children aged five and under) mortality (2002)**




Source: World Bank atlas - measuring development, World Bank

Livestock products require large quantities of water and animal feed to produce. It is predicted that there will be a change in eating habits in the developing countries and the demand for livestock products which have high environmental load will grow. In coping with the future global food issue, ensuring a proper balance between the production of grain and livestock products is an important perspective.

DATA 050 | **Figure 2-70 Ratio of grains used as feed in livestock breeding (2003)**

Livestock farmers raise animals by feeding them with abundant low cost grain, turning them into high value added meat. The ratio of grains used as animal feed becomes higher in countries with high income levels.

**Figure 2-71 Quantities of water and animal feed required for the production of 1kg of livestock/farm product and calorie efficiency**

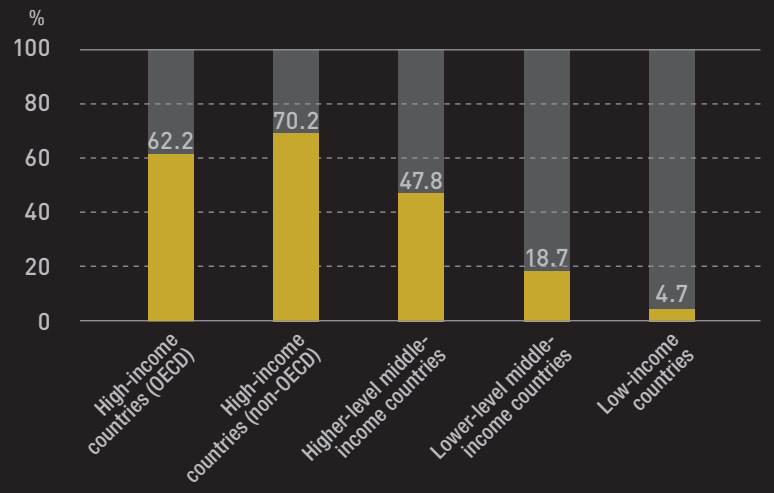
Livestock breeding requires large quantities of water and grain. In order to produce 1 kcal of livestock product, it requires approximately 3 kcal (3 times as much) of grain (converted as corn). There is a significant difference in the efficiency livestock animals convert grain into protein and chicken shows the highest efficiency followed by pork and beef. The efficiency in converting into beef is about one third of that of chicken. Taking in more animal protein from livestock with greater feed efficiency should help improve the productivity of land and water.







**Figure 2-70 Ratio of grains used as feed in livestock breeding (2003)**




Source: Agriculture and Food, WRI (original text: FAO data)

**Figure 2-71 Quantities of water and animal feed required for the production of 1kg of livestock/farm product and calorie efficiency**

| Livestock products Farm products (1 kg) | Necessary quantity of input | | |
|---|---|---|---|
| | Water (ℓ) | Cereals (Corn) (kg) | Amount of energy required to produce 1kcal of livestock product (Corn converted) (kcal) |
| Beef | 20,700 | 11 | 3.0 |
| Pork | 5,900 | 7 | 3.1 |
| Chicken | 4,500 | 4 | 3.1 |
| Chicken egg | 3,200 | — | — |
| White rice | 3,600 | — | — |
| Barley/naked barley | 2,600 | — | — |
| Soybean | 2,500 | — | — |
| Wheat | 2,000 | — | — |
| Corn | 1,900 | — | — |

Source: Results of trial calculation carried out by a group of researchers including Professor Taikan Oki of the Institute of Industrial Science, the University of Tokyo; the report on food self-sufficiency in Japan in 2003 by the Ministry of Agriculture, Forestry and Fisheries; and the Food Composition Database of the Ministry of Education, Culture, Sports, Science and Technology

It is expected that with the growth in economy in developing countries eating habits of the people will change, leading to increased demand for livestock products which have high environmental load. China is a typical example of such. On the other hand, India shows very little change in eating habits, which can be associated with religious factors.

DATA 051 | **Figure 2-72 Changes in income levels and demand for livestock products in China and India**

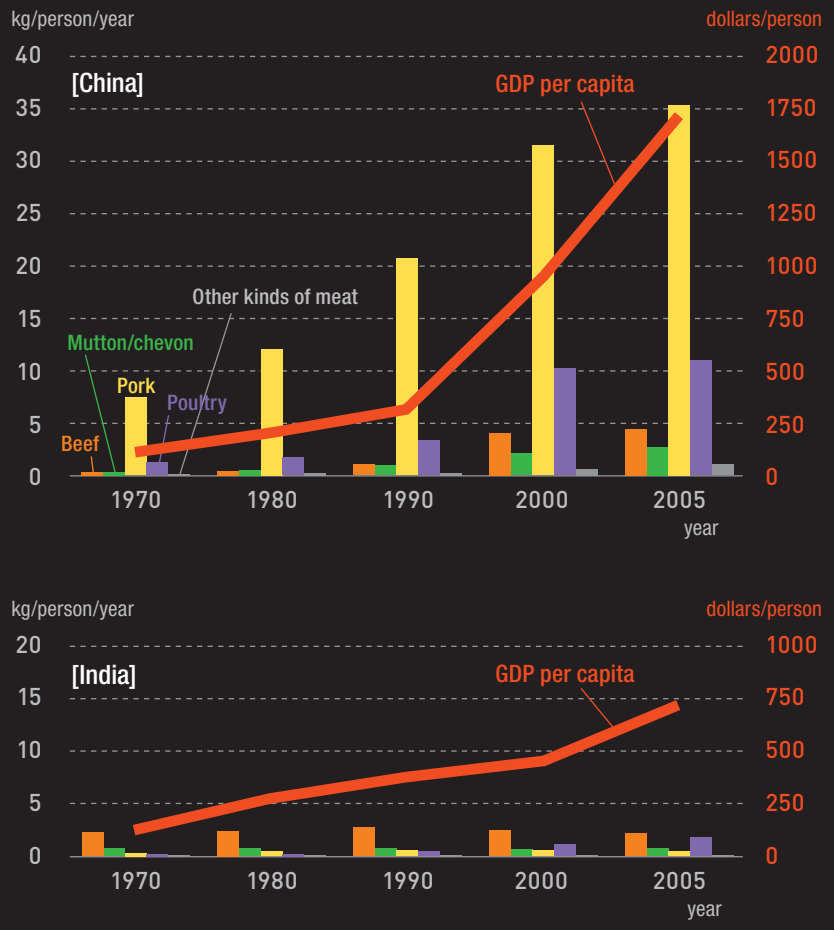
The figure shows the changes in the demand of livestock products per capita in China and India. In China, the consumption of livestock products has increased significantly in accordance with the increase in GDP per capita, indicating that the eating habits of the Chinese are becoming closer to those of developed countries. GDP per capita in India is also increasing but this has not led to a significant increase in the consumption of livestock products. The only noticeable feature is an increase in the consumption of poultry, which had remained at a very low level for a long time in this country. The low demand for livestock products in India may be largely attributable to the fact that nearly 70% of Indian people are Hindus: ahimsa (no butchery) and vegetarianism comprise an important part of the dogma of Hinduism.







**Figure 2-72 Changes in income levels and demand for livestock products in China and India**




Source: Food Balance Sheets, FAO and World Development Indicators Online Database, World Bank

A trend towards an increase in aquaculture can be seen due to economical concerns and to cope with the decrease in marine resources.

DATA 052 | **Figure 2-73 World capture fisheries and aquaculture production**

The quantity of fishery production is on a growing trend. Capture fisheries were on a growing trend until around 1990 but due to a decrease in resources, aquaculture production is now growing steeply. The percentage of aquaculture production compared to total fishery production grew from 13% in 1990 to 36% in 2007.

**Figure 2-74 Status of marine fishery resources (2007)**

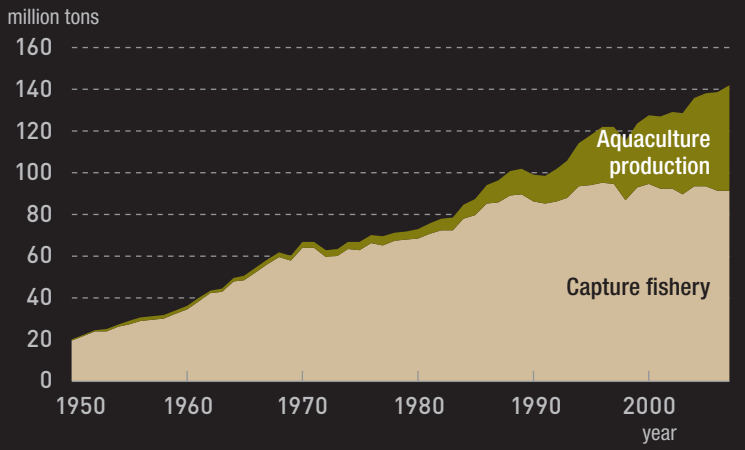
With the increase in marine capture fisheries, 9% of fish resources are currently designated as depleted (1% of which is recovering) and 19% are captured in excess of a sustainable production level. 52 percent are captured close to the limit of optimal production and have no room for expansion. If the situation regarding approximately 80% of fish resources captured at almost their limit or unsustainably change to a more appropriate fishery procedure, it could be possible to see the global fish resources to increase.





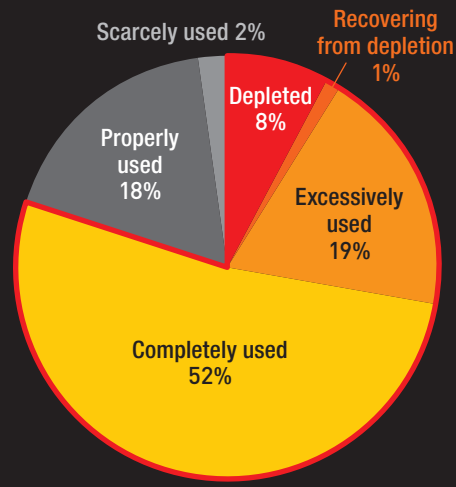


**Figure 2-73 World capture fisheries and aquaculture production**




Source: Fisheries and Aquaculture Information and Statistics Service Online Query Panels, FAO

**Figure 2-74 Status of marine fishery resources (2007)**




| | |
|---|---|
| Depleted: | Historically, catches have been very small, irrespective of the actual catches. |
| Recovering: | Once depleted, catches are beginning to increase again. |
| Excessively used: | Catches have already exceeded a production level that is sustainable for long periods. Producing more may possibly deplete resources. |
| Completely used: | No room for further expansion. The limit of optimal production has already been reached or has almost been reached. |
| Properly used: | Resources remain considerably far from the limit of production. Some of the resources still have room for expanded production. |
| Scarcely used: | Fishery is undeveloped or new. Significant scope for expanded production is evident. |

Source: The State of World Fisheries and Aquaculture 2008, FAO

# Crisis Creeping in

**Global Warming**

- Changes in global temperature
- Effects of global warming
- Greenhouse gas emissions

**Deterioration of Biodiversity**

- Extinction and the wonders of organisms
- Sphere of habitation of organisms shrinks

III

# Ⅲ Crisis Creeping in

## Changes in global temperature

Global warming is said to be an ongoing phenomenon.

DATA 053 | **Figure 3-1 Changes in global average surface temperature**

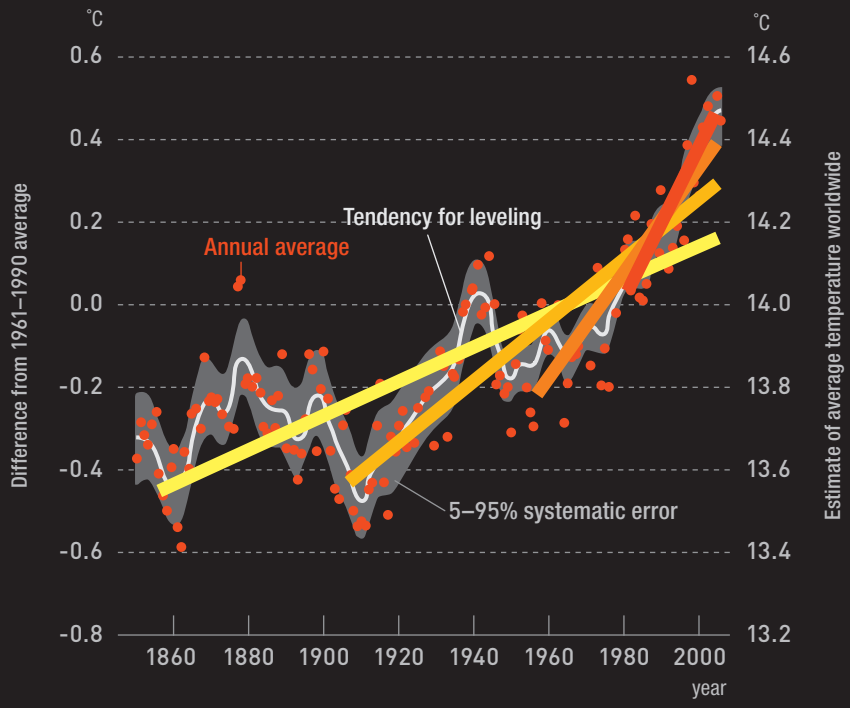
Scientific analysis shows that global average surface temperature has risen by approx. 0.7 degrees in the last 100 years. The rise became particularly steep since around 1950 and when the temperature rise for the last 50 years is looked at, the rate of increase is almost twice as great compared to that for the last 100 years.







**Figure 3-1 Changes in global average surface temperature**




Rate: Rate of temperature rise in 10 years by period. For example, the rise of 0.74 degrees in the last 100 years means that the temperature has risen by 0.074 degrees in the last 10 years.

Annual average: Annual values

Tendency for leveling: 10-year average

Systematic error: Extent of uncertainty as estimated from a comprehensive analysis of known uncertainty

| Period (years) | Rate (°C/10 years) |
|---|---|
| 25 | 0.177±0.052 |
| 50 | 0.128±0.026 |
| 100 | 0.074±0.018 |
| 150 | 0.045±0.012 |

Source: Technical summary of Working Group I Report of IPCC Fourth Assessment Report (Japanese translation), Japan Meteorological Agency

## Ⅲ Crisis Creeping in

### Changes in global temperature

When looking at the changes in global atmospheric temperature in the span of 400,000 years, the recent rise in the temperature shows a different pattern not seen in the climate change cycle of approximately 100,000 years.

DATA 054 | **Figure 3-2 Changes in global atmospheric temperature in the last 400,000 years**

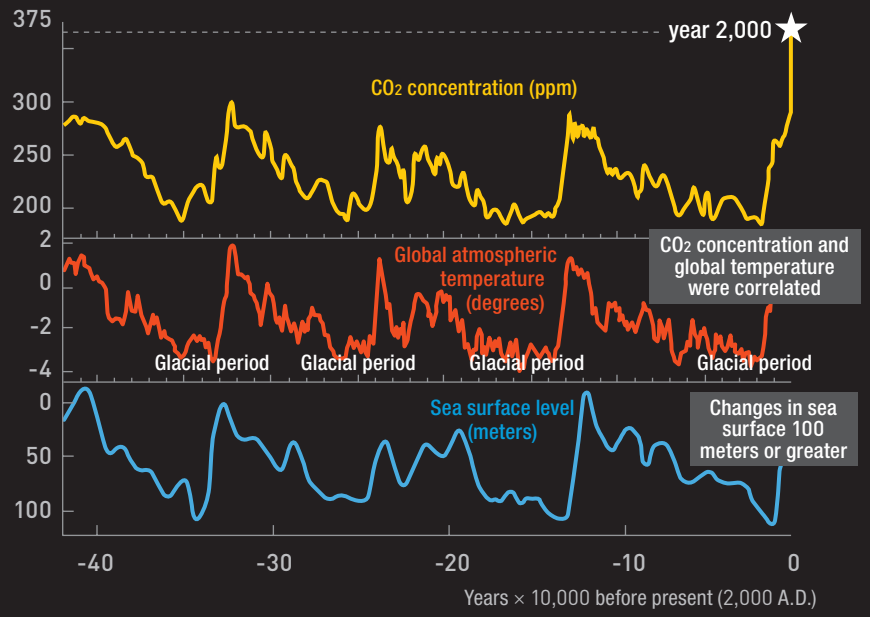
The analysis of continuous ice-sheet core records for the last 420,000 years led to a finding that the global temperature, atmospheric greenhouse gas concentration and sea level change showed a similar trend. During the last 420,000 years, there were four long cold periods and shorter warm periods which are called glacial and interglacial periods respectively. During these periods, the $CO_2$ concentration in the atmosphere fluctuated between approximately a minimum of 200ppm and a maximum of 300ppm. Current atmospheric $CO_2$ concentration has reached 390ppm and continues to rise.







**Figure 3-2 Changes in global atmospheric temperature in the last 400,000 years**




Source: Document for a lecture at the 17th Blue Planet Prize (Dr. Lorius, 2008)

# Ⅲ Crisis Creeping in

## Changes in global temperature

It was revealed recently that global warming was induced by human activity. How it will progress depends upon how humankind addresses the problem.

DATA 055 | **Figure 3-3 Global and continental temperature change**

According to the simulation results using a climate model show a high probability that most of the rises in global average surface temperature (observed values) from the mid-20th century onward were caused by a human-induced increase in greenhouse gas concentrations. It is highly probable that human-induced and pronounced warming has occurred in the last 50 years on all continents except the South Pole.

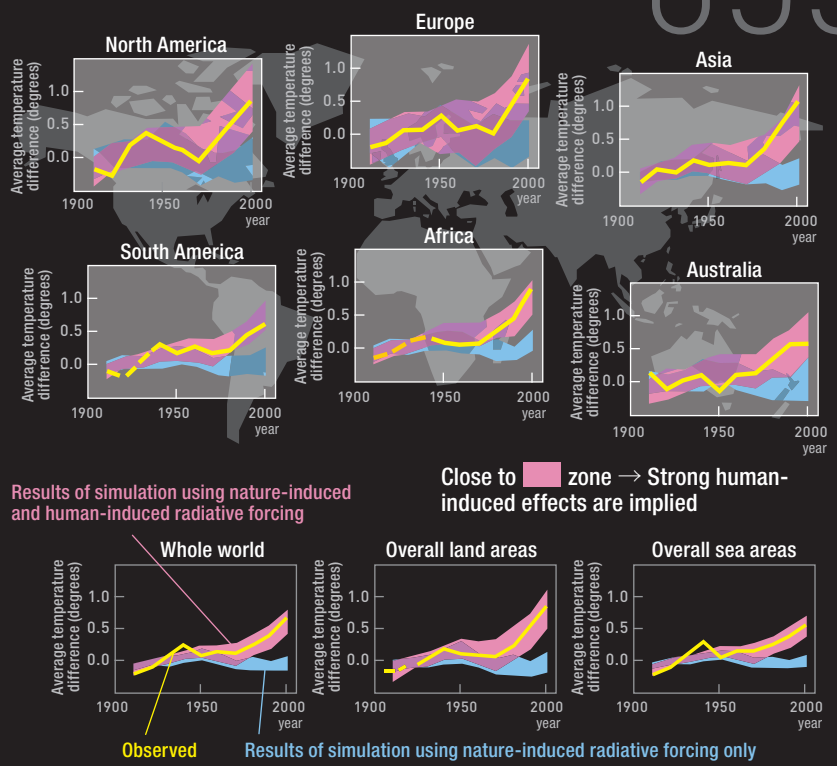
**Figure 3-4 Projected global average temperature change**

If greenhouse gas emissions continue to increase at a faster pace than at present, further warming could follow causing numerous changes in the climate systems around the world. The effects of the warming may depend on how societies change in the future but its scale is highly likely to be greater than that observed in the 20th century.





**Figure 3-3 Global and continental temperature change**




Source: Summary of Synthesis Report of IPCC Fourth Assessment Report for Policymakers, Ministry of Education, Culture, Sports, Science and Technology, Ministry of Economy, Trade and Industry, Japan Meteorological Agency and Ministry of the Environment

**Figure 3-4 Projected global average temperature change**

| Scenario | Temperature change (Change in the 2090-2099 period, with the change in the 1980-1999 period regarded as the standard (degrees).) | |
|---|---|---|
| | Optimal estimate | Range of likely values |
| Concentration in 2000 remains unchanged | 0.6 | 0.3 - 0.9 |
| B1 scenario | 1.8 | 1.1 - 2.9 |
| A1T scenario | 2.4 | 1.4 - 3.8 |
| B2 scenario | 2.4 | 1.4 - 3.8 |
| A1B scenario | 2.8 | 1.7 - 4.4 |
| A2 scenario | 3.4 | 2.0 - 5.4 |
| A1F1 scenario | 4.0 | 2.4 - 6.4 |

A1: Advanced growth society scenario. Divided into three: fossil energy sources (A1FI), non-fossil energy sources (A1T) and maintaining a proper balance of all energy sources (A1B) / A2: Pluralistic society scenario / B1: Sustainable growth-oriented society scenario / B2: Coexistence-oriented society scenario

Source: A summary of the Synthesis Report of the IPCC Fourth Assessment Report for Policymakers, Ministry of Education, Culture, Sports, Science and Technology, Ministry of Economy, Trade and Industry, Japan Meteorological Agency and Ministry of the Environment

Although the impact of global warming may depend on the extent of adaptation, the rate of temperature change and socioeconomic scenarios, if the temperature rise exceed 2 degree centigrade compared to the temperature during 1980-1999 period, it is estimated to result in extensive damages in many different areas.

DATA 056 | **Figure 3-5 Major effects of global average temperature rise**

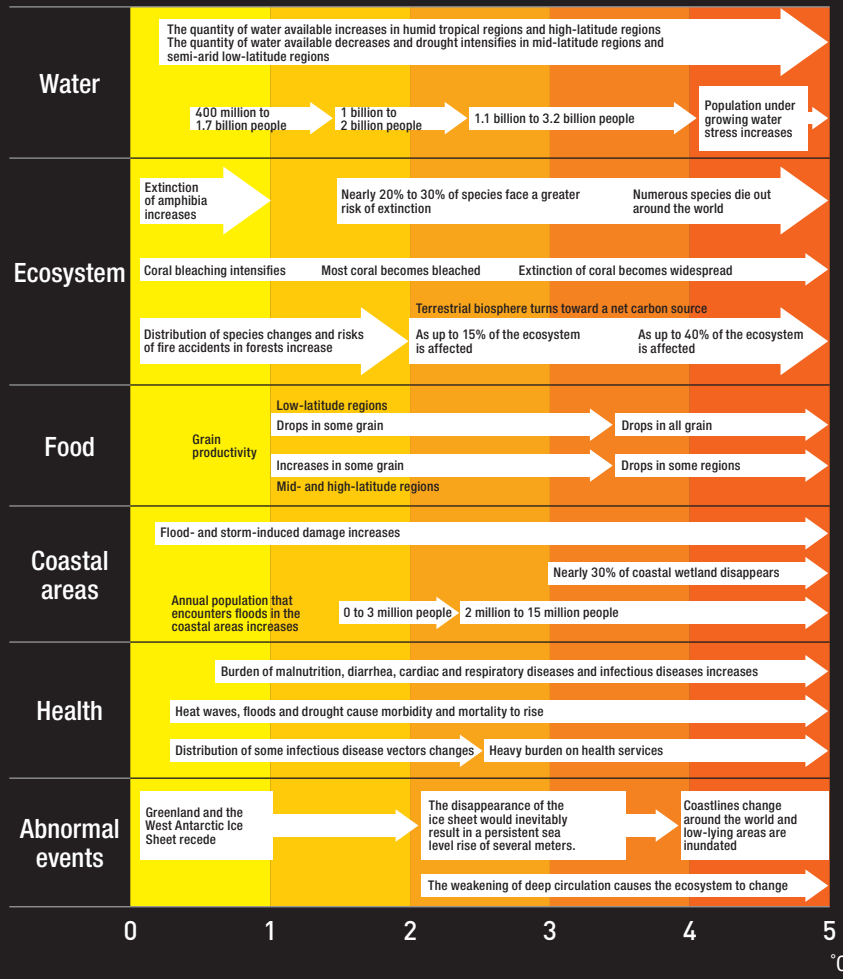
If global warming continues, available water resources will decrease due to the increase in drought in dry regions. The impact on the ecosystem will also be significant. An increase in tropical infectious diseases and various impacts on agriculture, forestry and fisheries are predicted. A rise in the sea level and an increase in natural disasters are also expected. They will affect the developing countries more severely that are less potent in taking preventive action due to financial and technical limitations.







**Figure 3-5 Major effects of global average temperature rise**




Source: Technical summary of Working Group 2 Report of IPCC Fourth Assessment Report (Japanese translation), Ministry of the Environment

The effects of the temperature rise depend on the region, and specifically on the latitude of the region. In particular, the effects of climate change are expected to be more severe in Asia and Africa, where developing countries account for larger proportion of the area.

DATA 057 | **Figure 3-6 Major effects of global average temperature rise (on regional level)**

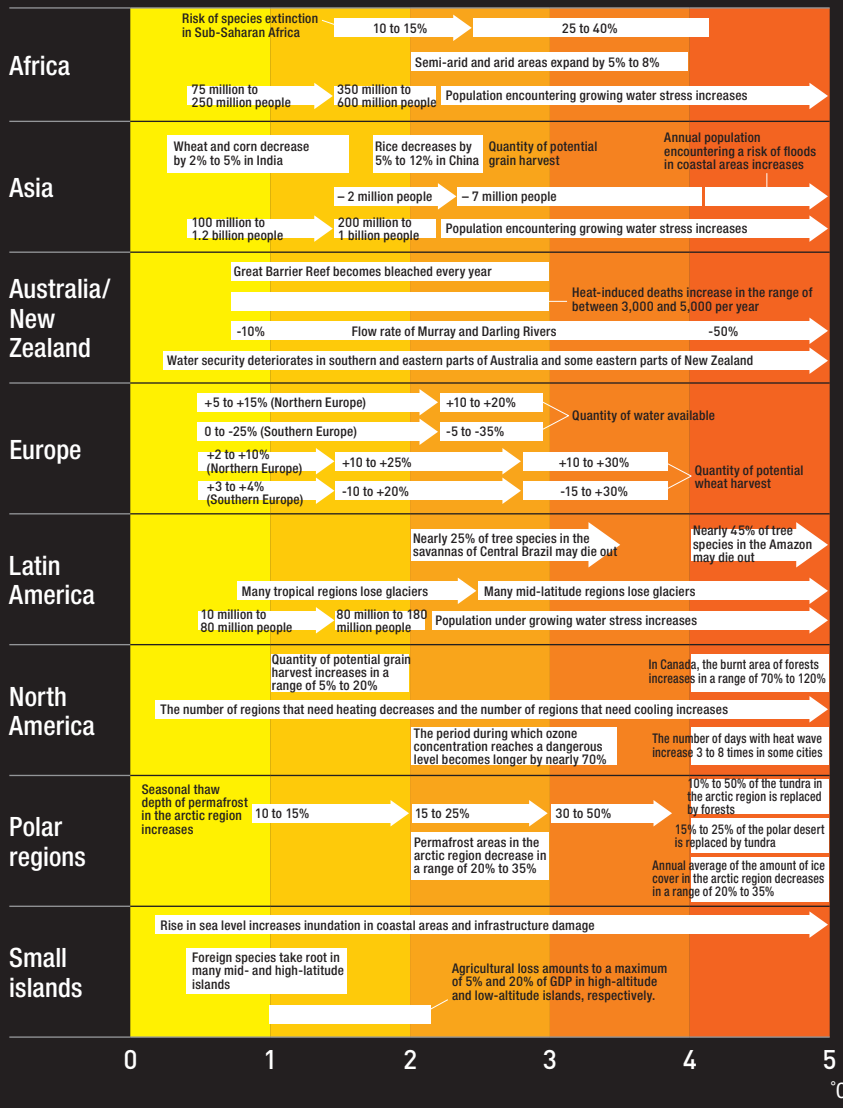
Although the severity and types of effects differ between regions, as global warming progresses it would adversely affect agriculture, ecosystems, water, coastal areas, health, industries, habitation and many other aspects of our lives.







**Figure 3-6 Major effects of global average temperature rise (on regional level)**




Source: Technical summary of Working Group 2 Report of IPCC Fourth Assessment Report (Japanese translation), Ministry of the Environment

# Ⅲ Crisis Creeping in
## Greenhouse gas emissions

The fact that $CO_2$, a greenhouse gas, is increasing in the atmosphere has been observed through various measurements. These increases in greenhouse gas emissions are attributable to human activities and are regarded as a direct cause of global warming.

DATA 058 | **Figure 3-7 Changes in $CO_2$ concentration in the atmosphere**

The Earth System Research Laboratory of the National Oceanic and Atmospheric Administration commenced its observation activity on $CO_2$ in the atmosphere in 1957, the International Geophysical Year. Data obtained by the Laboratory show that the amount of $CO_2$ in the atmosphere is on a yearly increasing trend while reflecting an annual fluctuation due to plant growth.

**Figure 3-8 Human-induced global greenhouse gas emission**

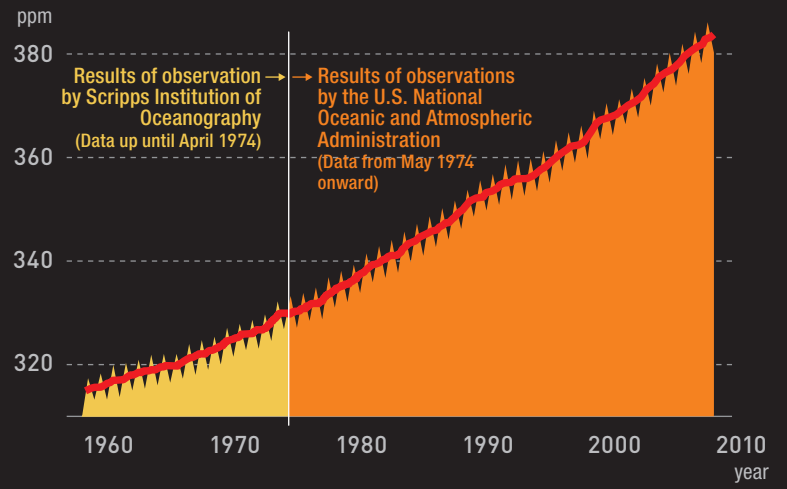
The increase in greenhouse gas emissions is attributable to human activities and is regarded as a direct cause of global warming. Human-induced global greenhouse gas emissions are increasing year after year and from 1990 to 2005, greenhouse gases increased by nearly 8 Gt in $CO_2$ equivalent globally. They are expected to continue to increase.





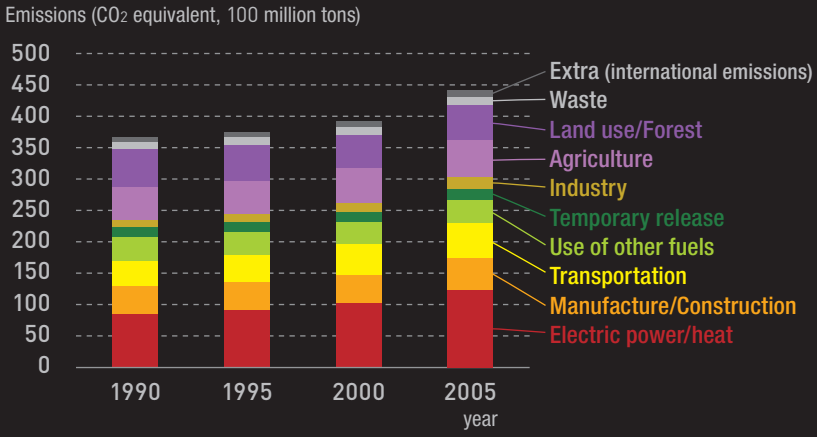


**Figure 3-7 Changes in $CO_2$ concentration in the atmosphere**




Source: Website of Earth System Research Laboratory of the National Oceanic and Atmospheric Administration (http://www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mlo.html)

**Figure 3-8 Human-induced global greenhouse gas emission**




Source: Climate Analysis Indicators Tool (CAIT) on-line database version 7.0, WRI

In order to reduce the emission of $CO_2$, an urgent review of energy supplies that involve mass consumption of fossil fuels is necessary.

DATA 059 | **Figure 3-9/Figure 3-10 Changes in energy-induced $CO_2$ emissions (by energy and by region)**

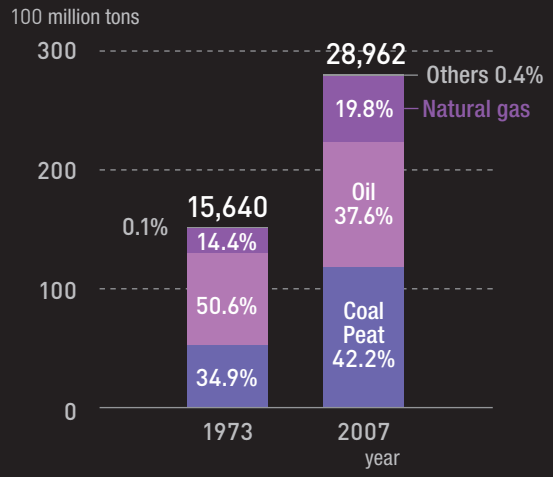
Emission of $CO_2$ is the highest among the greenhouse gases. Energy-induced $CO_2$ emission nearly doubled between 1973 and 2007. Although their usage percentages may vary, usage of all energy sources including coal, oil, natural gas and other fuels have individually increased. This is attributable to an increase in energy demand in China and other rising countries in Asia.





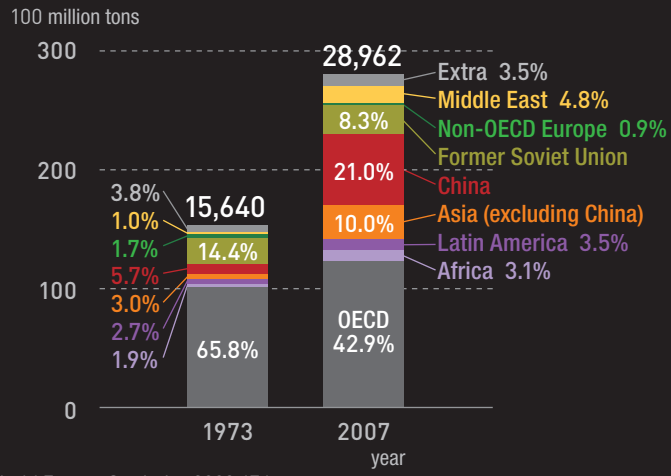


**Figure 3-9 Changes in energy-induced $CO_2$ emissions (by energy)**




Source: Key World Energy Statistics 2009, IEA

**Figure 3-10 Changes in energy-induced $CO_2$ emissions (by region)**




Source: Key World Energy Statistics 2009, IEA

# Ⅲ Crisis Creeping in
## Greenhouse gas emissions

The affluent lifestyle in developed countries is established on a foundation which consumes large amounts of fossil fuel energy. Unless special measures are implemented, $CO_2$ emissions will continue to increase with the growth of developing countries.

DATA 060 | **Figure 3-11 Amount of $CO_2$ emission by region (per capita, per GDP/2007)**

High-income countries consume large quantities of energy, thus their $CO_2$ emissions per capita are nearly triple of the global average. Meanwhile, the $CO_2$ emissions in South Asia and Sub-Saharan Africa range between one fourth and one fifth of the global average. Regional differences are significant. Per GDP, the $CO_2$ emissions in high-income countries are slightly below the global average.

**Figure 3-12 Changes in the amount of $CO_2$ emission by region and future projection**

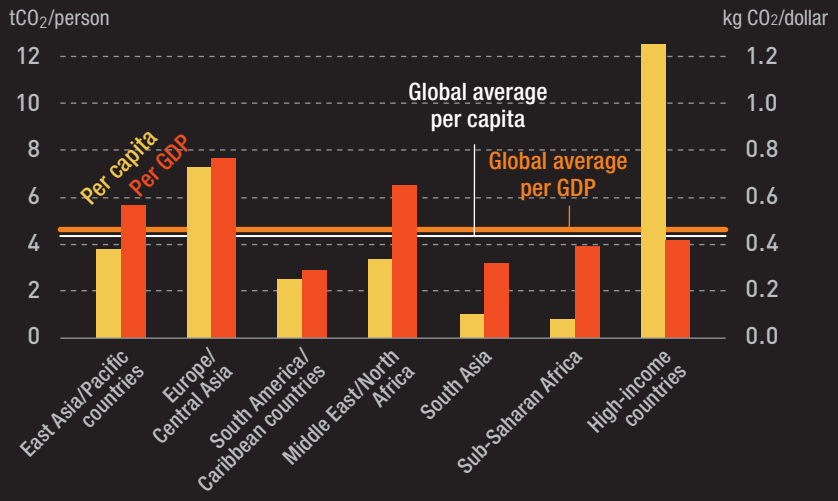
Unless measures are taken, energy source-induced $CO_2$ emission in 2030 is projected to double that of 1990. While emissions from developed countries such as the United States, EU countries, and Japan are projected to remain unchanged, those countries which are to have a dramatic economic growth such as China, India and ASEAN countries are expected to have an increase in emission.





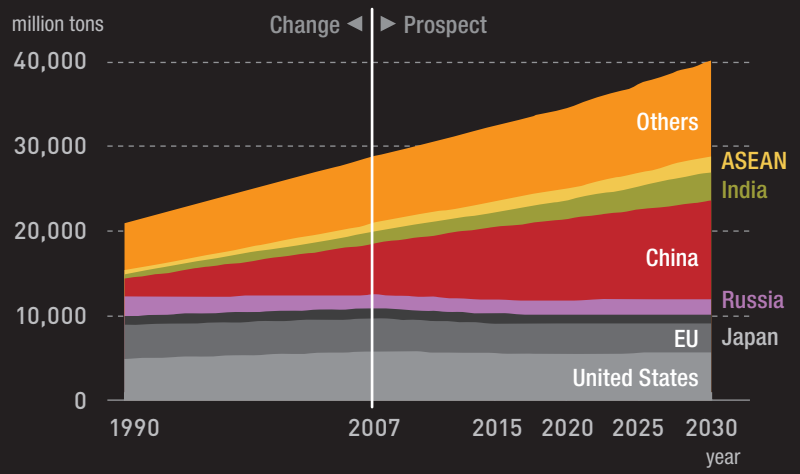


**Figure 3-11 Amount of $CO_2$ emission by region (per capita, per GDP/2007)**




Source: Key World Energy Statistics 2009, IEA

**Figure 3-12 Changes in the amount of $CO_2$ emission by region and future projection**




Source: World Energy Outlook 2009, IEA

Although small in number, there are countries which emit a large volume of $CO_2$. It goes without saying that efforts need to be made by such major emitting countries to reduce emissions, but even in other countries, lifestyles changes and shift to more energy efficient industries are needed to reduce the emissions per capita.

DATA 061 | **Figure 3-13 Proportion of $CO_2$ emissions by country (top 20 countries/2007)**

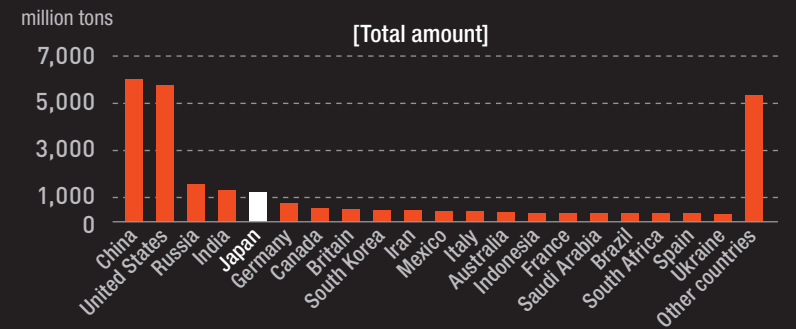
China (21%) and the United States (20%) are by far the largest $CO_2$ emitters. These two countries make up almost 40% of emissions worldwide. $CO_2$ emissions per capita are particularly high in developed countries, reflecting the sizes of their economies. $CO_2$ emissions per GDP are low in developed countries and high in other countries. $CO_2$ emissions per GDP show differences among countries in terms of their energy efficiencies and the rate of utilization of nuclear power generation.

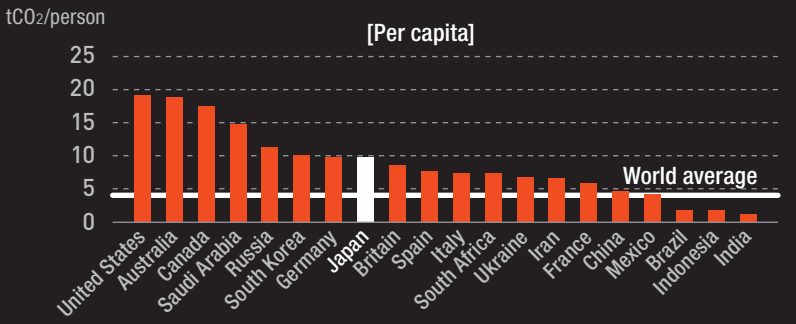


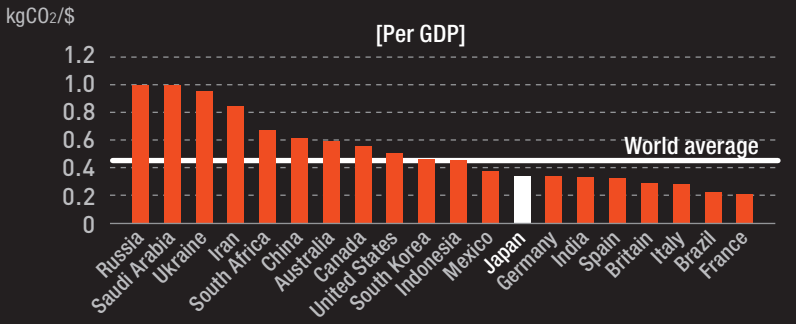




**Figure 3-13 Proportion of $CO_2$ emissions by country (top 20 countries/2007)**




Source: Key World Energy Statistics 2009, IEA

# Ⅲ Crisis Creeping in

## Extinction and the wonders of organisms

A pronounced decrease in the population of living organisms has been noted and numerous species have been found to be threatened with extinction in recent years. It is said that we are encountering a crisis of the sixth mass extinction of species in the history of Earth.

DATA 062 | **Figure 3-14 The Living Planet Index**

According to the Living Planet Index presented by the World Wide Fund for Nature (WWF) which summarizes the status of approximately 3,000 individual populations of living organisms in accordance with data published worldwide, the population of those species consistently decreased during the period between 1970 and 2000 by nearly 40%. The rate of decrease is almost 50% in inland aquatic species and 30% in marine and terrestrial species.

**Figure 3-15 Ratios of threatened species of animals and plants worldwide by taxonomic group**

The International Union for Conservation of Nature and Natural Resources (IUCN) studied the risk of extinction for nearly 1.64 million species humankind discovered. As a result, among approximately 45,000 species studied, nearly 40% were under threat of extinction.

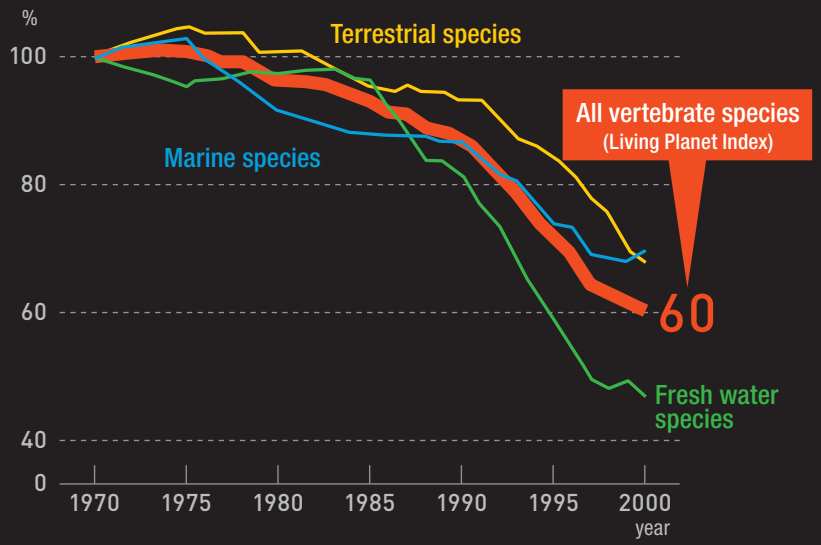






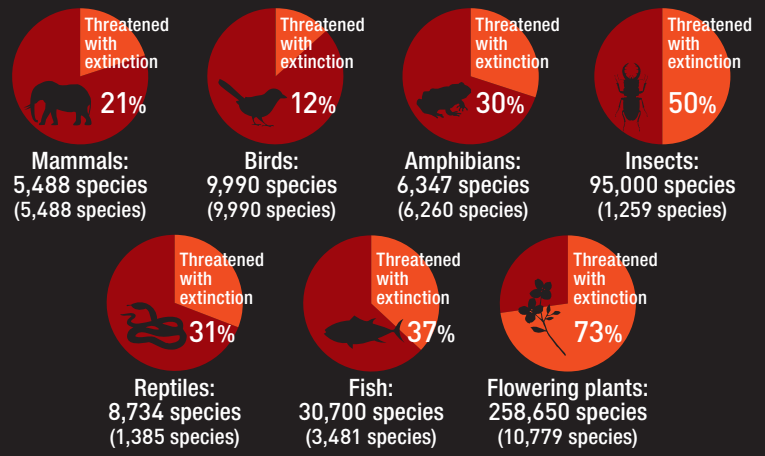
**Figure 3-14 The Living Planet Index**

(Assuming the population in 1970 to be 100)




Source: Global Biodiversity Outlook 2 (Japanese translation) published by the Japanese Ministry of the Environment
(Original text: Living Planet Report (2004), WWF, UNEP-WCMC and Global Footprint Network)

**Figure 3-15 Ratios of threatened species of animals and plants worldwide by taxonomic group**




Note: The numbers in parentheses are the numbers of species studied.
Source: Red List of Threatened Species (2008), IUCN

The rate of extinction of species has accelerated sharply in the last 100 years. Spurred by human activities, the rate of extinction is expected to accelerate further in the future.

DATA 063 | **Figure 3-16 Rate of extinction of species**

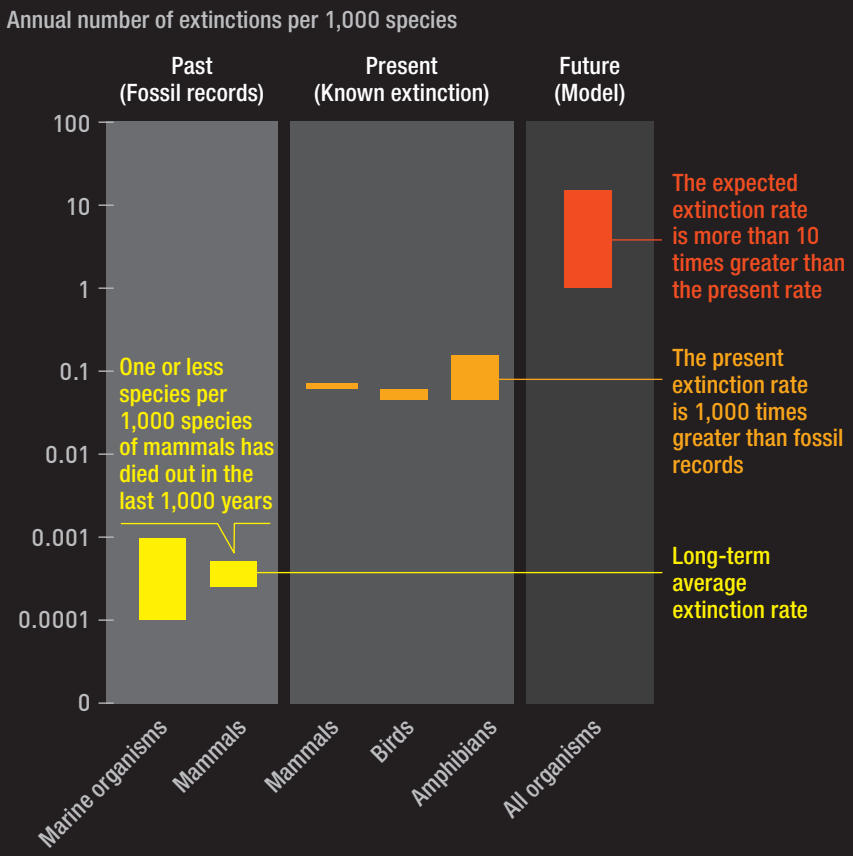
The extinction of species is something that occurs naturally and numerous species, among which dinosaurs being the representative, have become extinct in the past. The rate of extinction that have occurred naturally has been 0.1–1 species per 1,000 species per 1,000 years. Compared to this rate, in the last century, the rate was 50–500 times faster and when species that may already have become extinct were included, the rate of extinction can be projected to be 1,000 times greater. Worse still, the rate may further grow to more than 10 times of present in the future.







**Figure 3-16 Rate of extinction of species**




* [Past] shows the average extinction rate estimated from the fossil records.
Source: Annual Report on the Environment and the Sound Material-Cycle Society in Japan 2007
(Original text: Millennium Ecosystem Assessment, UN)

There is a huge loss of nature's bounty due to human activities. Although they may only account for only a few percent of the earth's surface, protecting "hot spots" allows to conserve numerous species.

DATA 064 | **Figure 3-17 Biodiversity hotspots (2004)**

According to the definition by Dr. Norman Myers, the 10th Blue Planet Prize laureate, "hotspots" are regions having high biodiversity on a global scale but are on the edge of its destruction. Conservation International, the winner of the 6th Blue Planet Prize, specified 34 hotspots. These hotspots account for only 2.3% of the surface area of the earth. Nevertheless, it has been found that 75% of threatened mammals, birds and amphibians, 50% of all vascular plants and 42% of terrestrial vertebrate animals inhabit only in these 34 hotspots.





**Figure 3-17 Biodiversity hotspots (2004)**

Hotspots

Source: Biodiversity Hotspots, Conservation International

From a distant past, humankind has enjoyed the ecosystem services biodiversity provided. However, humankind takes this nature's bounty for granted and are not aware of the seriousness of losing them.

DATA 065 | **Figure 3-18 Relationship between ecosystem services and human welfare**

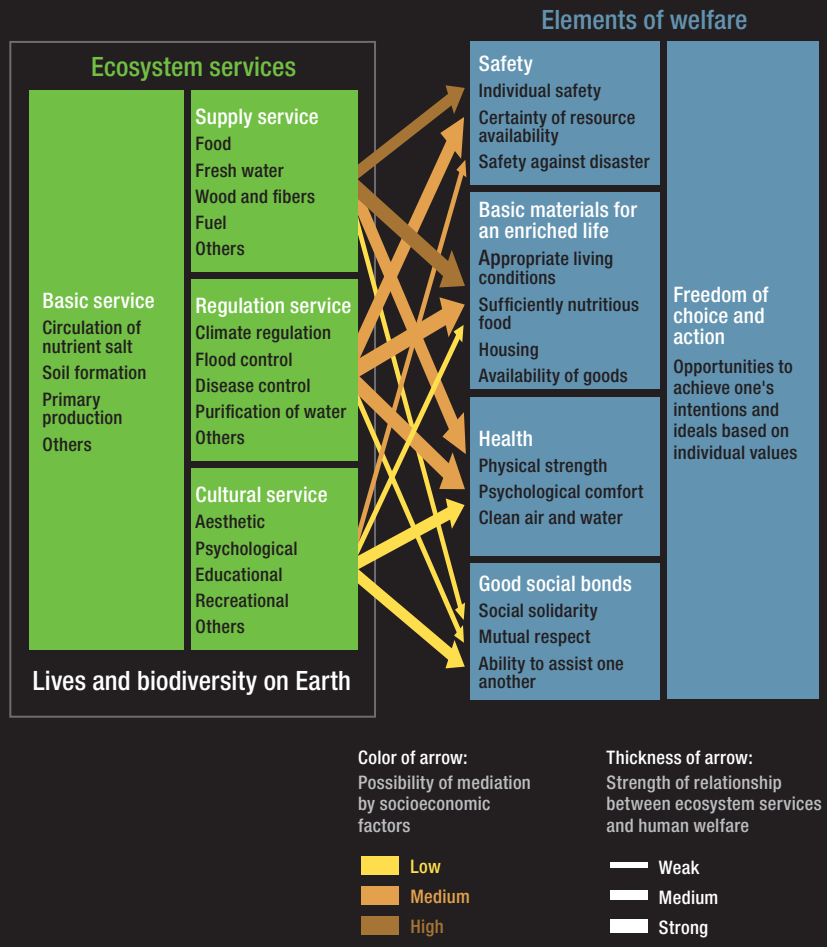
The relationship between various types of ecosystem services and human welfare is influenced in many ways by social and economic activities. It is necessary to ensure that nature's bounty is enjoyed sustainably while giving consideration to regional ecosystems and social diversity.







**Figure 3-18 Relationship between ecosystem services and human welfare**




Source: Annual Report on the Environment and the Sound Material-Cycle Society in Japan 2007
(Original text: Millennium Ecosystem Assessment, UN)

Ecosystem services that are indispensable for the survival of humankind are already in a critical condition.

DATA 066 | **Figure 3-19 Global status of ecosystem services**

The Millennium Ecosystem Assessment of the United Nations analyzed the benefits humankind has enjoyed from ecosystems on Earth (ecosystem services) and reviewed the ecosystem services provided for the last several decades to an extent determinable. Almost two-thirds (15 out of 24) of ecosystem services have deteriorated or are no longer sustainable. Among those include a drop in marine catches, loss of forests and wetlands, and important functions such as purification of air and water, protection against disasters and others.







**Figure 3-19 Global status of ecosystem services**

| | Function | Classification | Condition | Note |
|---|---|---|---|---|
| Provisioning services | Food | Crops | ↗ | Substantial production increase |
| | | Livestock | ↗ | Substantial production increase |
| | | Capture fisheries | ↘ | Declining production due to overharvest |
| | | Aquaculture | ↗ | Substantial production increase |
| | | Wild food | ↘ | Declining production |
| | Fiber | Timber | → | Forest loss in some regions, growth in others |
| | | Cotton, hemp, silk | → | Declining production of some fibers, growth in others |
| | | Woody fuel | ↘ | Declining production |
| | Genetic resources | | ↘ | Lost through extinction and genetic resource loss |
| | Biochemicals, natural medicines, pharmaceuticals | | ↘ | Lost through extinction, overharvest |
| | Water | Fresh water | ↘ | Unsustainable use for drinking, industry and irrigation; amount of hydro energy unchanged, but dams increase ability to use that energy |
| Regulating services | Air quality regulation | | ↘ | Decline in ability of atmosphere to cleanse itself |
| | Climate regulation | Global | ↗ | Net source of carbon sequestration since mid-century |
| | | Regional and local | ↘ | Preponderance of negative impacts |
| | Water regulation | | → | Varies depending on ecosystem change and location |
| | Erosion regulation | | ↘ | Increased soil degradation |
| | Water purification and waste treatment | | ↘ | Declining water quality |
| | Disease regulation | | → | Varies depending on ecosystem change |
| | Pest regulation | | ↘ | Natural control degraded through pesticide use |
| | Pollination | | ↘ | Apparent global decline in abundance of pollinators |
| | Natural hazard regulation | | ↘ | Loss of natural buffers (wetlands, mangroves) |
| Cultural services | Spiritual and religious values | | ↘ | Rapid decline in sacred groves and species |
| | Aesthetic value | | ↘ | Decline in quantity and quality of natural lands |
| | Recreation and ecotourism | | → | More areas accessible but many degraded |

Source: Annual Report on the Environment and the Sound Material-Cycle Society in Japan 2007
(Original text: Millennium Ecosystem Assessment, UN)

Global measures must be taken against human activities that deteriorate the ecosystems to prevent them.

DATA 067 | **Figure 3-20 Main direct drivers of change in biodiversity and ecosystems**

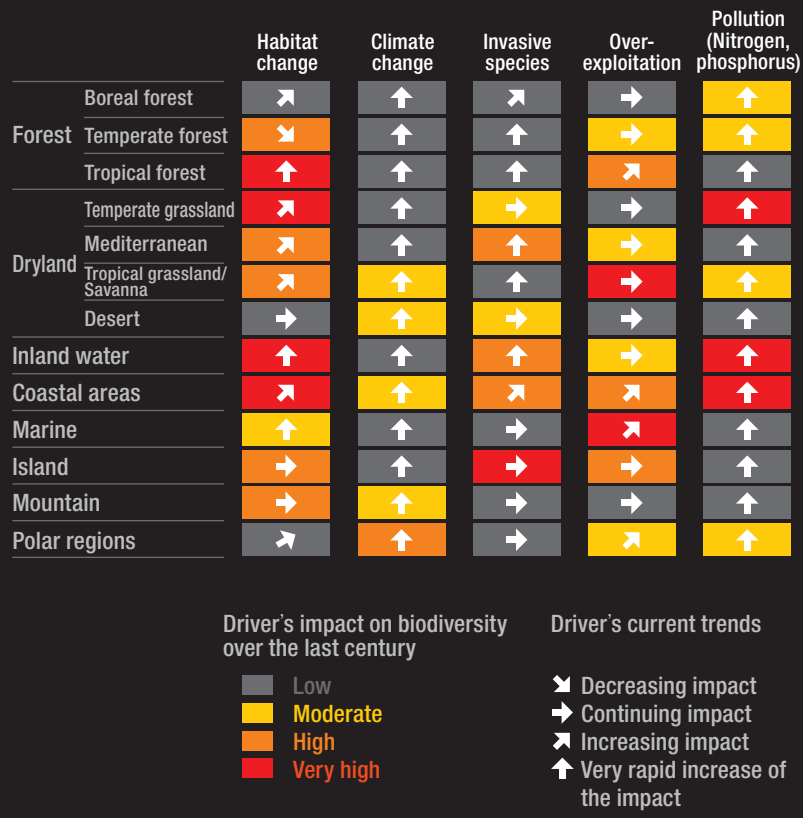
It is considered that the major causes in the loss of biodiversity are the alteration of habitats, alien species, excessive exploitation, contamination with nutrient salts such as nitrogen and phosphorus, and global warming, among others. In particular, the expansion of farmland and excessive exploitation of fishery resources are pointed out as major causes. These direct impacts on biodiversity loss are expected to remain at the same level or increase further.







**Figure 3-20 Main direct drivers of change in biodiversity and ecosystems**




Source: Global Biodiversity Outlook 2 (Japanese translation) published by the Japanese Ministry of the Environment
(Original text: Millennium Ecosystem Assessment, UN)

Forestry ecosystems and their distribution differ from region to region. Active conservation measures are requested in countries with large forest areas.

DATA 068 | **Figure 3-21 World forest distribution by region (2005)**

Europe and South America both have large forest areas and they account for a large part of the land in these regions. While the forest area is increasing in Europe, the forest area in South America is decreasing faster than in any other region in the world.

**Figure 3-22 Countries with large land areas and countries with large forest stock (2005)**

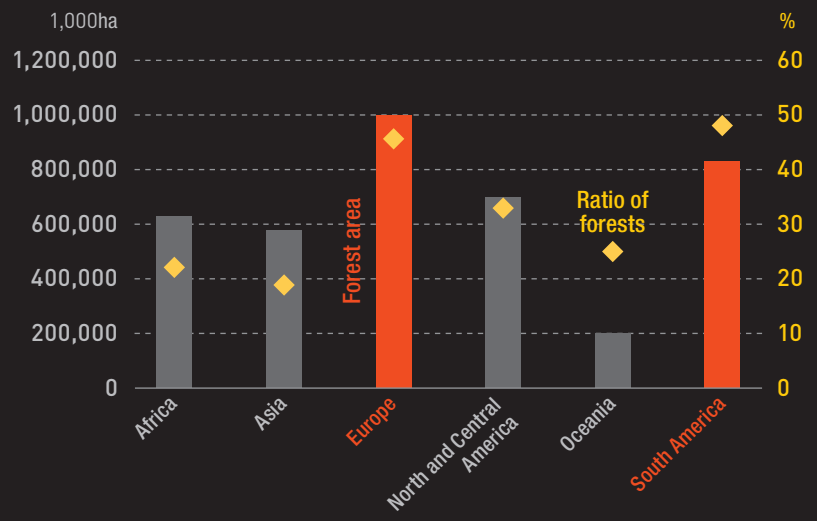
Countries with large forest area are Russia, followed by Brazil, Canada and the United States. In Japan, forest accounts for two-thirds of all land, and is consistently amassed. Internationally, Japan is a country rich in forest resources but is also one of the major importers of timber in the world.







**Figure 3-21 World forest distribution by region (2005)**




Source: Global Forest Resources Assessment 2005 Progress towards sustainable forest management, FAO

**Figure 3-22 Countries with large land areas and countries with large forest stock (2005)**

| Country | Forest stock (1000ha) | Ranking | Land area (1000ha) | Ranking | Ratio of forest (%) |
|---|---|---|---|---|---|
| Russia | 808,790 | 1 | 1,638,139 | 1 | 49.4 |
| Brazil | 477,698 | 2 | 845,942 | 5 | 56.5 |
| Canada | 310,134 | 3 | 909,351 | 4 | 34.1 |
| United States | 303,089 | 4 | 916,192 | 3 | 33.1 |
| China | 197,290 | 5 | 932,749 | 2 | 21.2 |
| Australia | 163,678 | 6 | 768,230 | 6 | 21.3 |
| Democratic Republic of Congo | 133,610 | 7 | 226,705 | 12 | 58.9 |
| Indonesia | 88,495 | 8 | 181,157 | 15 | 48.8 |
| Peru | 68,742 | 9 | 128,000 | 19 | 53.7 |
| India | 67,701 | 10 | 297,319 | 7 | 22.8 |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| Japan | 24,868 | 23 | 36,450 | 61 | 68.2 |

Source: FAOSTAT, FAO

Forest areas continue to decrease globally with a few exceptions in some regions. It is a challenge for the survival of humankind to conserve the forests which absorb $CO_2$ that cause global warming and foster numerous living organisms.

DATA 069 | **Figure 3-23 Annual net change in forests by region (1990–2005)**

Global forest area is on a decreasing trend. The net annual decrease in forest areas from 2000 to 2005 is projected to be 7.3 million hectares (73,000 km²). The rate of net annual loss in forest areas is 0.18%. By region, forest areas are decreasing in South America, Africa and Southeast Asia, while there are increases in China and some European countries.

**Figure 3-24 Top 10 countries with the greatest changes in forest areas (2000–2005)**

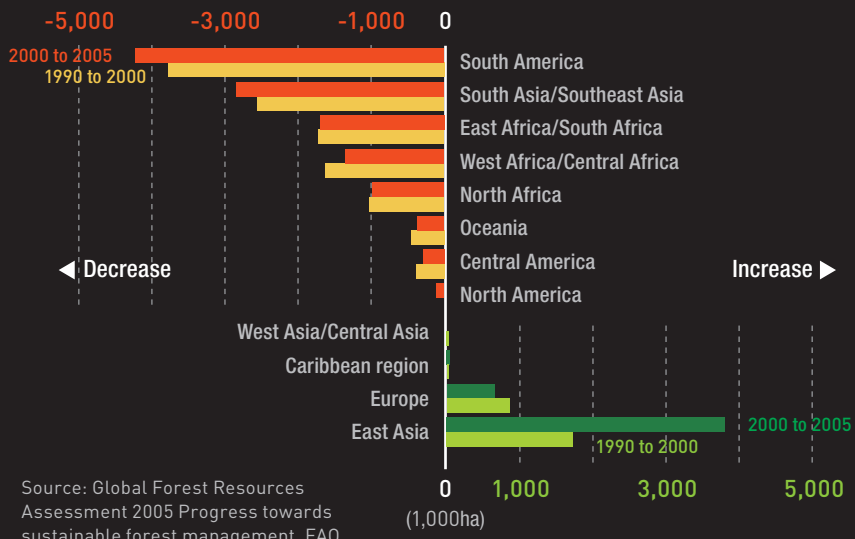
From 2000 to 2005, Brazil was highest in the decrease in forest areas, followed by Indonesia. The decrease in forests in these countries is attributable to deforestation resulting from pasture reclamation and agricultural burning, as well as road construction. China undertook afforestation during the same period. As a result, the forest areas in China increased significantly.





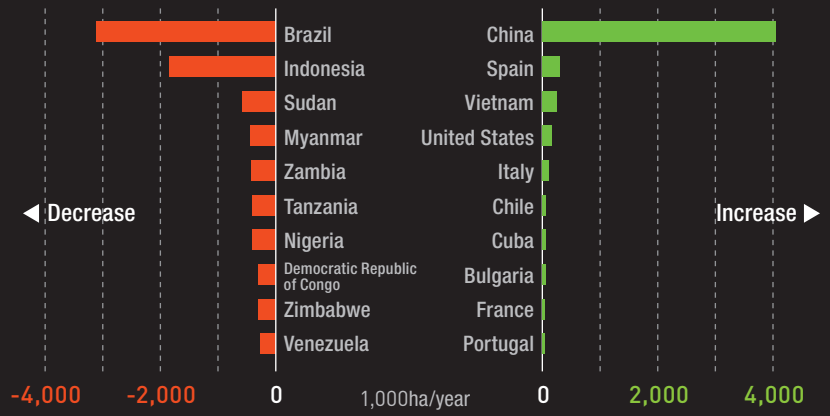


**Figure 3-23 Annual net change in forests by region (1990–2005)**




Source: Global Forest Resources Assessment 2005 Progress towards sustainable forest management, FAO

**Figure 3-24 Top 10 countries with the greatest changes in forest areas (2000–2005)**




Source: Global Forest Resources Assessment 2005 Progress towards sustainable forest management, FAO

Deforestation aggravates the global environment. We must stop deforestation that is occurring all over the world.

DATA 070 | **Figure 3-25 Changes in land use/cover in recent decades**

In the last 50 years, life for mankind changed drastically (with an increase in demand for resources), resulting in a rapid change in the ecosystem never seen historically. Studies conducted from 1980 onwards indicate that forests worldwide have undergone drastic changes in the last few decades. The regions where deforestation is occurring are the Amazon region which is rich in forest resources, Central Africa, Russia and the coniferous forest zone of North America. Deforestation in these regions is expected to have a significant effect on the global environment.





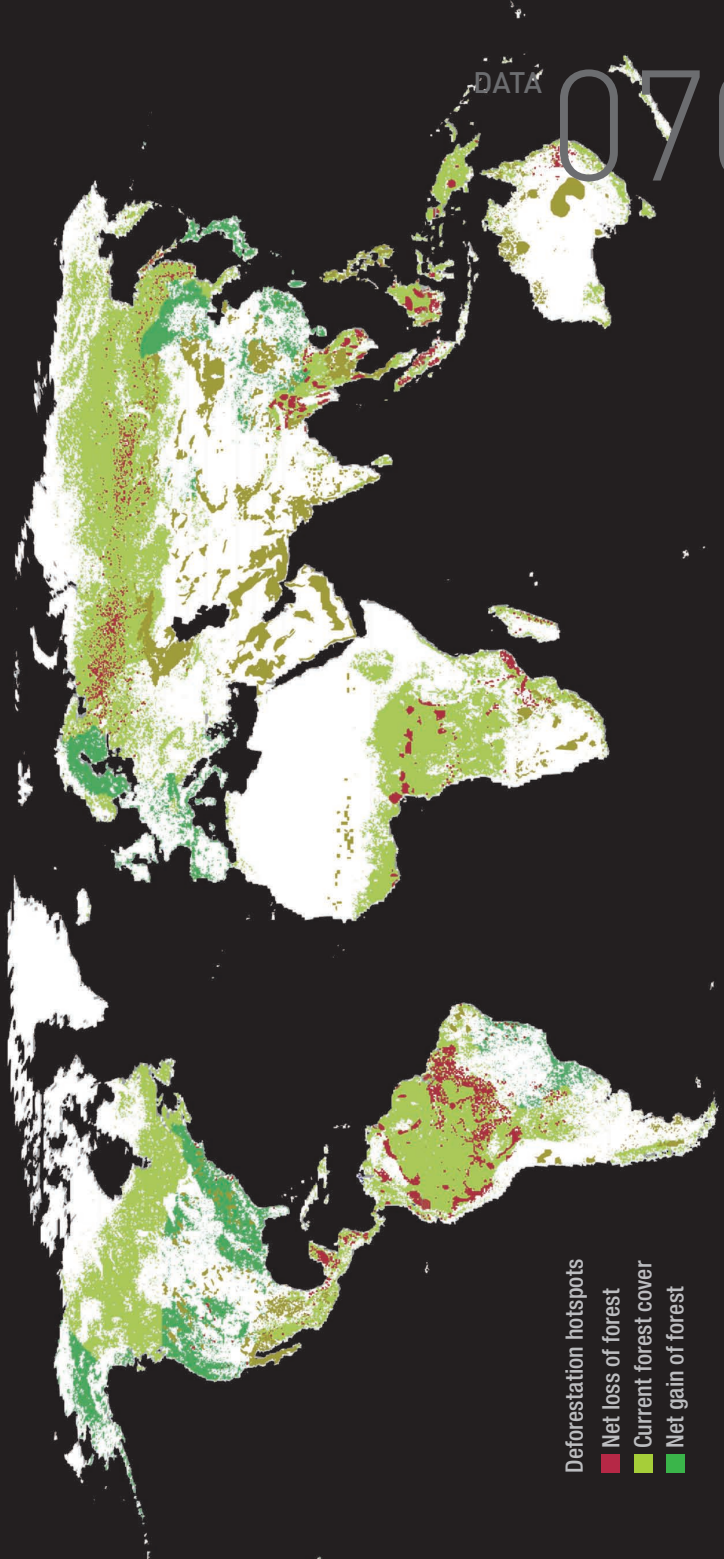



**Figure 3-25 Changes in land coverage in recent decades**

Source: Global Biodiversity Outlook 2 (Japanese translation) published by the Japanese Ministry of the Environment (original text: Millennium Ecosystem Assessment, UN)

## Ⅲ Crisis Creeping in

### Sphere of habitation of organisms shrinks

Desertification is another factor causing uncertainty in terms of food supply, water shortages, poverty and other problems. Such desertification which hugely affects people's lives is progressing in various places of the world.

DATA 071 | **Figure 3-26 Current situation regarding desertification in the world**

Arid regions, which are susceptible to the effects of desertification, occupy nearly 41% of the land surface area. Many such regions are in developing countries.





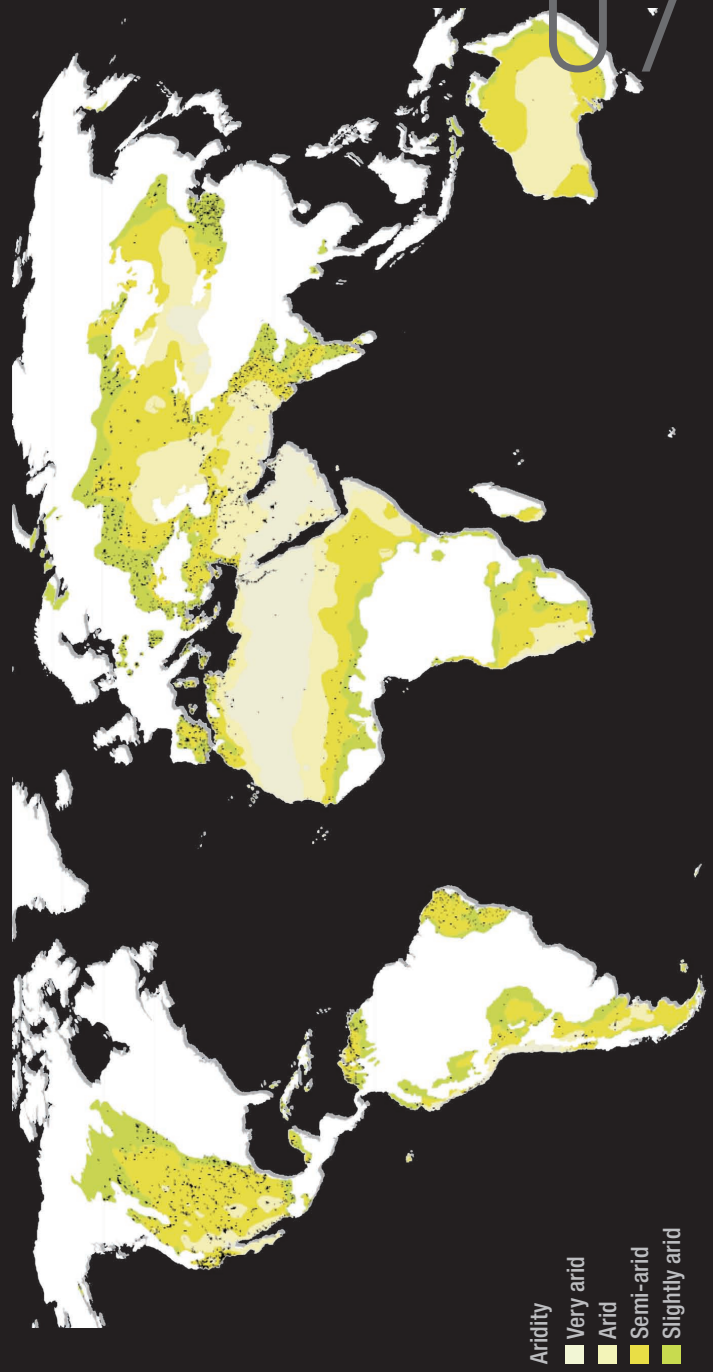



**Figure 3-26 Current situation regarding desertification worldwide**

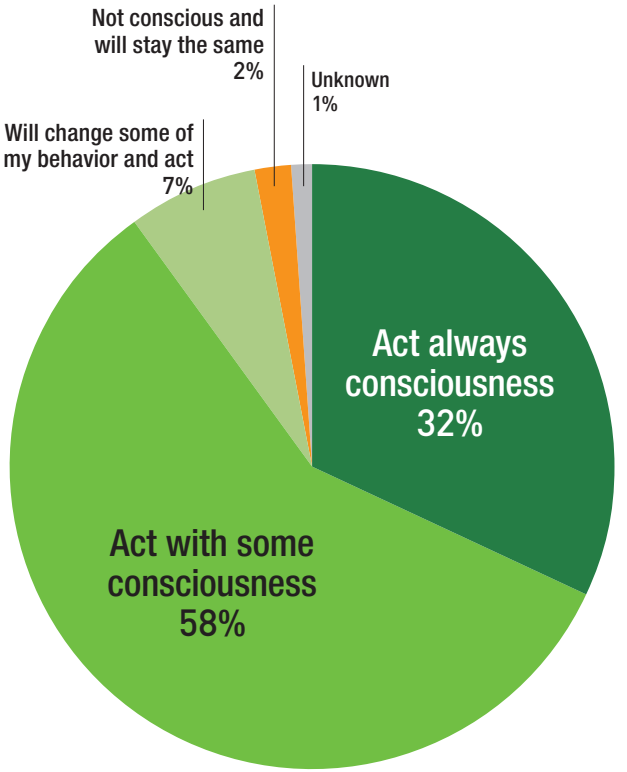
# Actions Against Crisis



# IV

How do the learned in the world view actions taken by individuals in trying to prevent global warming?

**Figure 4-1 Prevention of global warming** (2009)



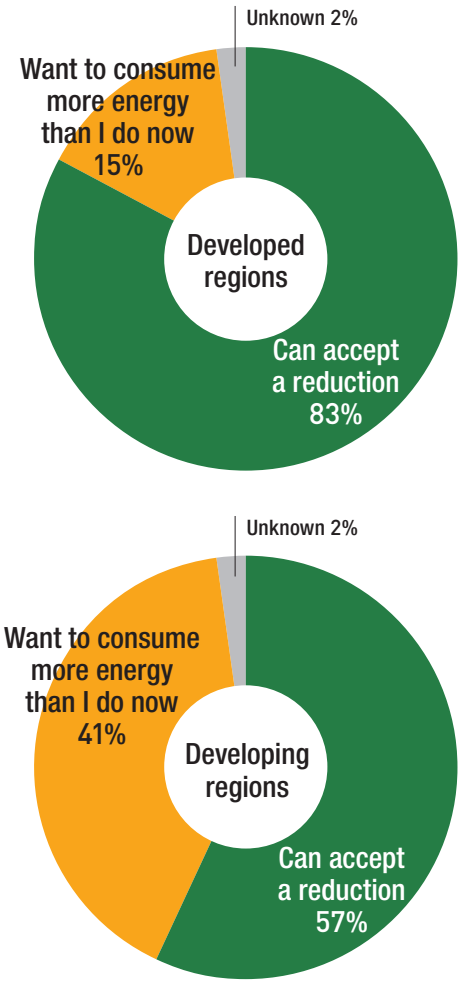

Source: Environmental Survey Report 2009, The Asahi Glass Foundation

DATA 072 | **Figure 4-1 Prevention of global warming (2009)**

People's awareness level towards participating in preventing global warming is fairly high climbing to over 90% when those who responded "I am aware of it to some extent" is included. It is hoped that this high percentage will be reflected in the actions taken.

How conscious are the people regarding energy consumption? The difference in their awareness between developed regions and developing regions reflect those facts such as the ease of accessibility to the energy or the differences in the amount of energy supplied.

**Figure 4-2 Reduction in energy consumption** (2006)



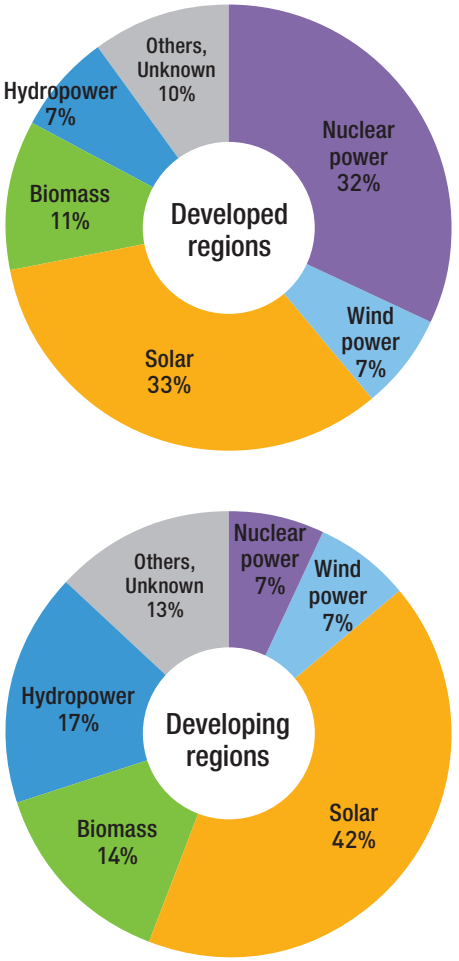

Source: Environmental Survey Report 2006, The Asahi Glass Foundation

DATA 073 | **Figure 4-2 Reduction in energy consumption (2006)**

More than 80% of respondents in developed regions answered that they could accept a reduction in their energy consumption. In developing regions, just under 60% of respondents said that they could accept a reduction in their energy consumption. More than 40% wanted to consume more energy than they do now, differing greatly from their counterparts in developed regions.

What would be the most favorable energy source to replace fossil fuels? Considerable differences in view were expressed between developed regions and developing regions.

**Figure 4-3 Most favorable energy source to replace fossil fuels** (2006)




Source: Environmental Survey Report 2006, The Asahi Glass Foundation

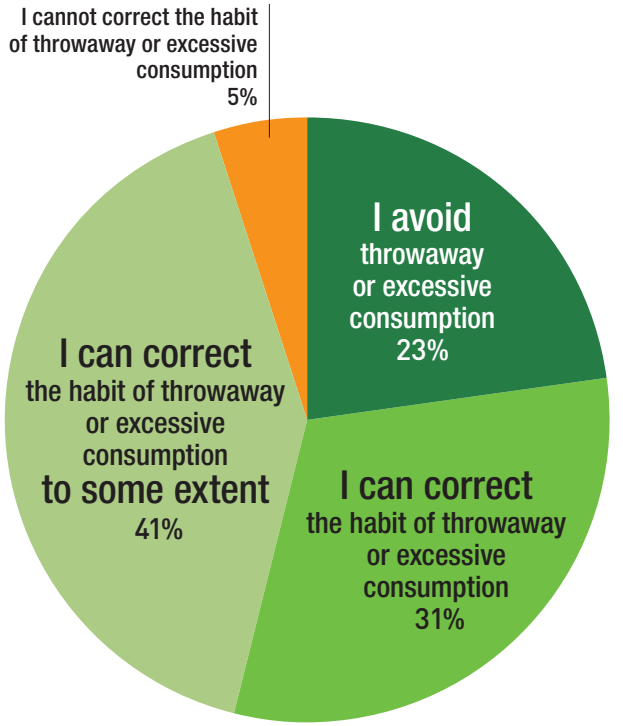
DATA 074 | **Figure 4-3 Most favorable energy source to replace fossil fuels (2006)**

While nuclear power and solar were raised as favorable energy sources to replace fossil fuels in developed regions, there were high expectations towards solar as the only source to replace in developing regions. This may reflect the technical difficulties involved in the installation of power generation equipment.

DATA 075

How do the respondents view their lifestyles? The survey results show that many people are motivated to switch to more sustainable lifestyles.

**Figure 4-4 Changes in lifestyles** (2008)




Source: Environmental Survey Report 2008, The Asahi Glass Foundation

DATA 075 | **Figure 4-4 Changes in lifestyles (2008)**

Ninety-five percent of respondents said they avoided or could (fully or to some extent) correct the habit of throwaway or excessive consumption. Many people believed that they could correct their lifestyles. It is now to what extent can they put this motivation into practice.

Although there may be numerous constraints in using renewable energies, how big a potential do these renewable energies have?

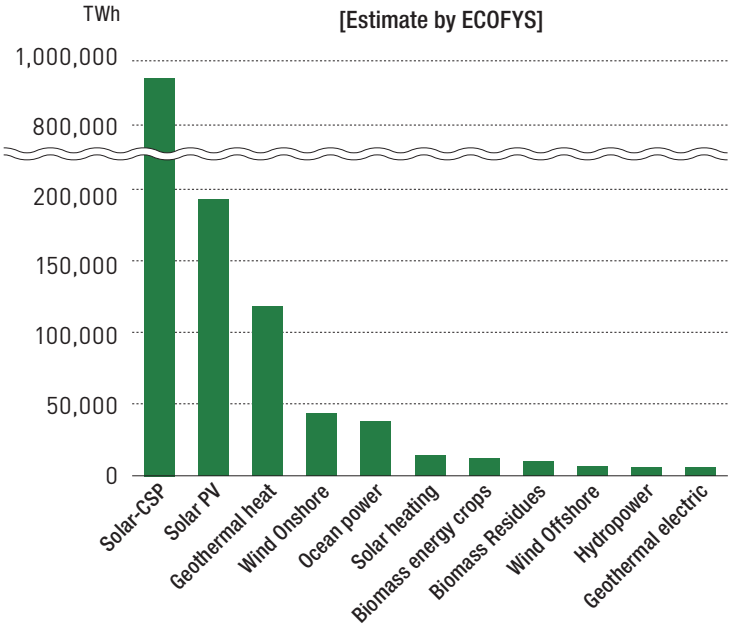
DATA 076 | **Figure 4-5 Technological potential of renewable energy**

The figure shows the technological potential of renewable energies based on estimate calculations made by relevant institutes. The estimate calculations on the potential of renewable energy vary between studies. Nevertheless, worldwide electricity generation in 2006 (19,015 TWh) has certainly been far outstripped.

Note 1: Renewable energy has strong potential, however, geographical constraints (land coverage etc.) and technological constraints (energy conversion efficiency etc.) limit the amount of renewable energy available. The potential of renewable energy mentioned in the figure involves giving consideration to these constraints.

Note 2: Worldwide electricity generation in 2006 (19,015 TWh) is calculated from World Energy Statistics and Balances, OECD/IEA.

**Figure 4-5 Technological potential of renewable energy**




| Renewable energy | Estimates by relevant institutes | | ECOFYS estimate |
|---|---|---|---|
| | Minimum value | Maximum value | |
| Solar-CSP | 28,311 | 1,210,388 | 918,151 |
| Solar PV | 152,740 | 1,685,616 | 192,808 |
| Geothermal heat | 445 | 1,437,215 | 118,721 |
| Wind Onshore | 7,683 | 51,735 | 43,253 |
| Ocean power | 37,614 | 37,808 | 37,808 |
| Solar heating | - | - | 14,041 |
| Biomass energy crops | 5,559 | 176,941 | 11,016 |
| Biomass Residues | 3,425 | 19,406 | 10,000 |
| Wind Offshore | 1,610 | 2,158 | 6,507 |
| Hydropower | 5,183 | 5,879 | 5,708 |
| Geothermal electric | 160 | 16,438 | 5,137 |
| Total TWh | 242,728 | 4,643,584 | 1,363,151 |

Source: Role and Potential of Renewable Energy and Energy Efficiency for Global Energy Supply, ECOFYS

Countries worldwide are making efforts to facilitate conversion to renewable energy with the aim of addressing global environmental issues.

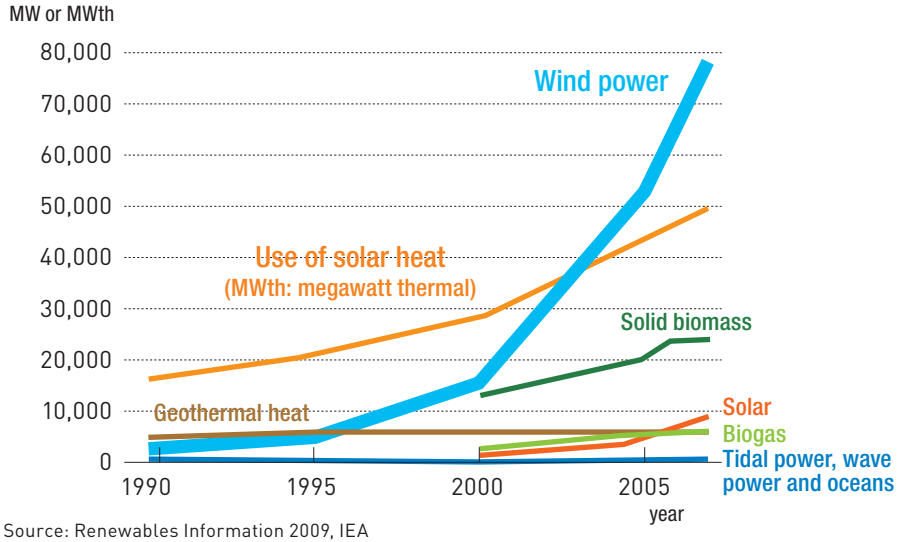
DATA 077 | **Figure 4-6 Power-generating capacity of renewable energy (OECD countries)**

Renewable energy such as hydropower and geothermal heat has long been used. But to deal with the deepening global environmental problems and the limitation on resources, there is now a need to spread worldwide the use of various renewable energies on a massive scale. Currently, developments and extensions of new technologies are underway. The use of renewable energy is increasing, including wind power, biomass and photovoltaic power generation.

**Figure 4-7 Extent of introduction of renewable energy and its share in supply of primary energy**

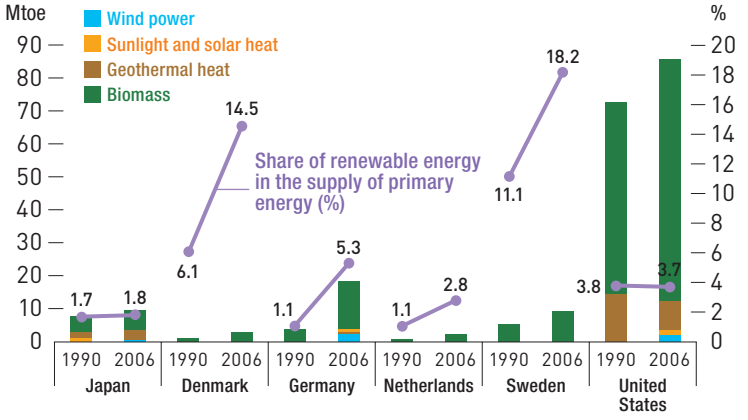
In terms of renewable energy other than large-scale hydropower, biomass energy is the source most introduced worldwide and its introduction is particularly pronounced in the United States. The share of renewable sources in the supply of primary energy is large in Sweden (mainly biomass) and Denmark (mainly wind power), but it remains low at only a few percent in other developed countries. Renewable energies serve an important role in propelling measures to tackle global warming. Policies to let citizens choose which renewable energy market to promote such as feed-in tariff in Europe, tradable green certificates are being implemented. However, there are still problems to be solved in the introduction of renewable energies such as the issue of stable supply of electricity in case of solar and wind power generation, and the competition between fuel crops and food in case of biofuels.

**Figure 4-6 Power-generating capacity of renewable energy (OECD countries)**




Source: Renewables Information 2009, IEA

**Figure 4-7 Extent of introduction of renewable energy and share in supply of primary energy**




Note: The IEA statistics use data on inputted fuels to make a primary conversion of electricity related to biomass for power generation. 10% efficiency is assumed for geothermal heat, while 100% efficiency is assumed for other energy sources (wind power, solar, wave power, ocean etc.).
Source: FY 2009 Annual Energy Report
(Original text: Renewables Information, Energy Balances of OECD Countries, IEA)

DATA 078

The amount of solar energy reaching earth is shown in comparison with the amount of energy used by humankind. The comparison speaks eloquently how large the amount of solar energy is.

**Figure 4-8 Amount of solar energy reaching Earth**

| | | Amount of energy (tons of oil equivalent) |
|---|---|---|
| **Sunlight**<br>Solar energy irradiated onto Earth: 174PW<br>Practically available solar energy: 1PW[1] | | |
| Available solar energy (per year) | | $7.53\times10^5$ Mtoe |
| World's annual supply of primary energy (2008) | | $0.12\times10^5$ Mtoe |
| **Fossil fuels** | Reserves (2007) | |
| Oil | 1.2379 trillion barrels[2] | $1.68\times10^5$ Mtoe |
| Coal | 847.5 billion tons[2] | $5.87\times10^5$ Mtoe |
| Natural gas | 177 trillion $m^3$ [2] | $1.84\times10^5$ Mtoe |
| **Uranium** | 5.47 million tons[3] | $0.75\times10^5$ Mtoe |
| | Total energy reserves | $10.14\times10^5$ Mtoe |

1) B. Sorensen, Energy Policy(1991) 386-391
2) BP, Statistical Review of World Energy 2008
3) OECD/NEA-IAEA, Uranium2007

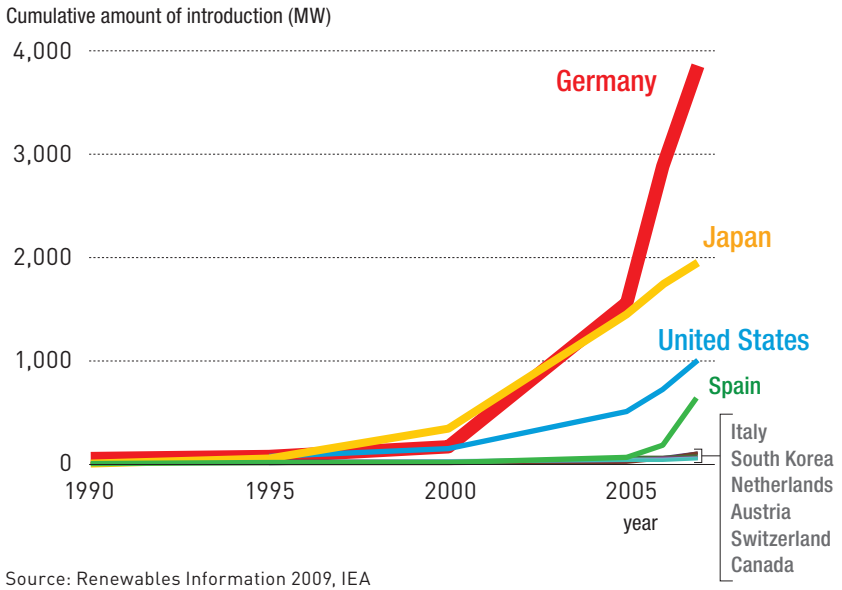
DATA 078 | **Figure 4-8 Amount of solar energy reaching Earth**

The amount of solar energy that reaches Earth in a year and could be available to humankind is far greater than the amount of energy currently used worldwide. It is comparable to the reserves of energy resources such as fossil fuels and uranium.

DATA 079

How is the use of solar energy which is said to be infinite progressing?

**Figure 4-9 International comparison of the amount of photovoltaic power generation introduced**




Source: Renewables Information 2009, IEA

DATA 079 | **Figure 4-9 International comparison of the amount of photovoltaic power generation introduced**

The amount of photovoltaic power generation introduced reached 7,800MW in OECD countries in 2007, more than ten times the capacity compared to that in 2000. Germany, Japan and the United States are the major introducers, and the rate of increase in introduction has been substantial in recent years. Japan remained as the top country in the amount of photovoltaic power generation capacity introduced for a long time until it was overtaken by Germany in 2005.

Although renewable energies are regarded as favorable means in dealing with the global environmental problems, currently however, there are still quite a few disadvantages that need to be overcome, and future technological innovations are awaited.

DATA 080 | **Figure 4-10 Advantages and disadvantages of renewable energy**

While the introduction and expansion of renewable energies are necessary to deal with the global environmental problems, there still remain issues among them that are to be solved in terms of cost, supply, safety and others.

**Figure 4-10 Advantages and disadvantages of renewable energy**

| | Power generation cost | Advantages | Disadvantages |
|---|---|---|---|
| **Sunlight** | 15 to 1,500 US$/MWh | · No $CO_2$ is generated during power generation<br>· Purely domestic energy<br>· No constraint on resources | · Low energy density<br>· Power cannot be generated at night or in rainy weather<br>· Equipment cost is high |
| **Wind power** | 35 to 95 US$/MWh | · No $CO_2$ is generated during power generation<br>· Purely domestic energy<br>· No constraint on resources | · Low energy density<br>· Electricity generation depends on wind conditions, which affects the system<br>· Equipment cost is high |
| **Hydropower** | 40 to 80 US$/MWh | · No $CO_2$ is generated during power generation<br>· Purely domestic energy<br>· Because it is easy to start and stop operation, hydropower excels in load following capability | · Environments of dam construction sites and downstream areas of dams may change and affect ecosystems<br>· Electricity generation depends on the amount of water and rainwater in the areas where power plants are located |
| **Biomass** | NA | · Sustainable use is possible and will not lead to an increase in $CO_2$, provided that the amount of consumption is equal to or less than the amount of production<br>· The only renewable resource that, as a source of carbon, can be converted into many kinds of synthetic raw material, including liquid fuel | · Because of its poor density and quantity of production, collecting biomass involves a tremendous amount of labor and costs<br>· Biomass generally contains a large amount of moisture and less heat. Regional and seasonal differences are significant |
| **Nuclear power** | 21 to 31 US$/MWh | · No $CO_2$ is generated during power generation<br>· Countries supplying uranium are scattered internationally and their political situations are stable. Fuel prices of uranium remain more stable than those of fossil fuels<br>· Uranium will be available for 2,570 years provided that the utilization of plutonium becomes feasible | · Uranium is a radioactive substance and requires extensive safety equipment and strict safety control<br>· Radioactive waste is generated and must be disposed of and managed very strictly |

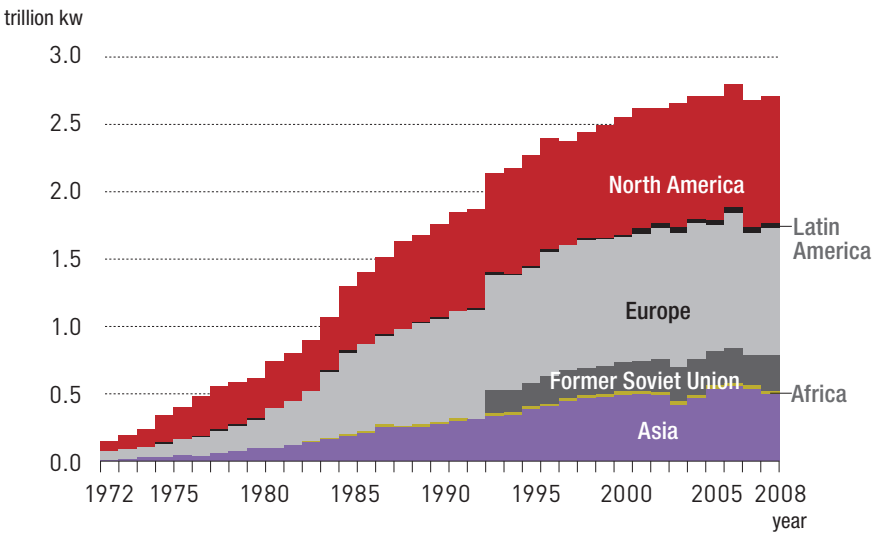
The power generation costs are average values in the existing power sources of different countries based on the assumption that the discount rate is 5% (IEA survey)

Source: Projected Costs of Generating Electricity (2005 Update), IEA

DATA 081

Nuclear energy which do not emit $CO_2$ while generating power is considered to be one of the major options in dealing with the global warming problem.

**Figure 4-11 Changes in electricity generated by nuclear power worldwide (by region)**




Source: FY 2009 Annual Energy Report
(Original text: NUCLEONICS WEEK, The McGraw-Hill Companies)

DATA 081 | **Figure 4-11 Changes in electricity generated by nuclear power worldwide (by region)**

The number of nuclear power generating facilities and the amount of electricity generated by them are increasing consistently in Asia. In Europe and the United States, existing nuclear power plants are proactively increasing their generation capacities and their electricity outputs are in an increasing trend.

The introduction of nuclear power generation is expected to expand, especially in Asia.

DATA 082 | **Figure 4-12 An outlook for nuclear power generation worldwide**

In developing countries such as those in Asia (e.g. China, India), the introduction of nuclear power generation is expected to expand dramatically from the perspective of ensuring stable energy supply to correspond to their economic growth.

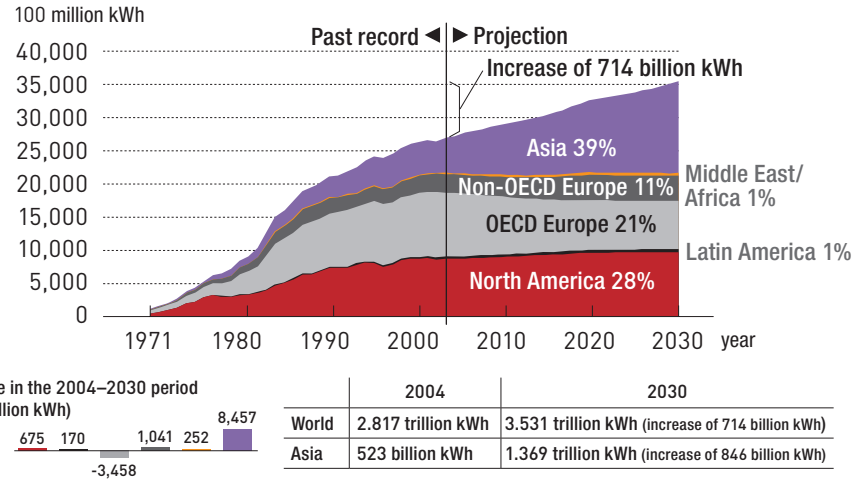
**Figure 4-13 Current and future development of nuclear power generation in Asia**

Currently, 109 nuclear reactors are in operation generating approx. 85 million kW of power in Asia, mainly in Japan, South Korea and China. Including facilities that are under construction or planned, Asia will have 181 nuclear reactors worth approx. 160 million kW of power generation capacity.





## Figure 4-12 An outlook for nuclear power generation worldwide




Increase in the 2004–2030 period (100 million kWh)




| | 2004 | 2030 |
|---|---|---|
| World | 2.817 trillion kWh | 3.531 trillion kWh (increase of 714 billion kWh) |
| Asia | 523 billion kWh | 1.369 trillion kWh (increase of 846 billion kWh) |

Source: Asia/World Energy Outlook 2006, The Institute of Energy Economics, Japan

## Figure 4-13 Current and future development of nuclear power generation in Asia

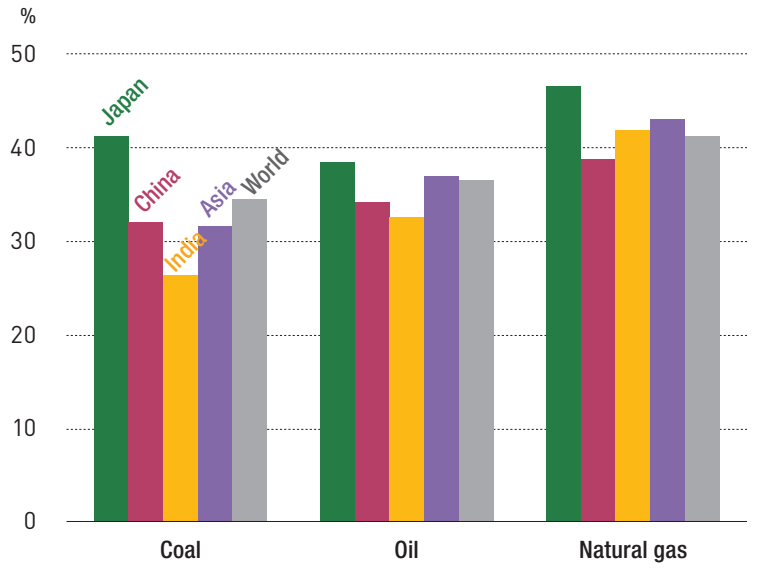
As of January 1, 2009 (10,000 kW, gross electric output)

| Country/Region | Operating | | Under construction | | Planned | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Output | Number of units | Output | Number of units | Output | Number of units | Output | Number of units |
| Japan*1 | 4,793.5 | 53 | 394.8 | 4 | 1,655.2 | 12 | 6,843.5 | 69 |
| South Korea | 1,771.6 | 20 | 680.0 | 6 | 280.0 | 2 | 2,731.6 | 28 |
| China | 911.8 | 11 | 1,333.5 | 13 | 1,360.9 | 13 | 3,606.2 | 37 |
| Taiwan | 516.4 | 6 | 270.0 | 2 | | | 786.4 | 8 |
| India | 412.0 | 17 | 316.0 | 6 | 680.0 | 8 | 1,408.0 | 31 |
| Pakistan | 46.2 | 2 | 32.5 | 1 | | | 78.7 | 3 |
| Indonesia | | | | | 400.0 | 4 | 400.0 | 4 |
| Vietnam | | | | | N/A | 1 | N/A | 1 |
| Asia total | 8,451.5 | 109.0 | 1,713.5 | 32.0 | 4,376.1 | 40.0 | 15,854.4 | 181.0 |
| World total | 39,044.4 | 432 | 2,940.4 | 52 | 6,536.7 | 66 | 50,356.2 | 550 |
| Figures in parentheses are values for the previous year. | (39,224.1) | (435) | (3,140.5) | (43) | (4960.1) | (53) | (48061.4) | (531) |

*1: The statistics of Japan are valid as of March 31, 2009.
Source: Trend of Development of Nuclear Power Generation Worldwide 2009, Japan Atomic Industrial Forum, Inc.

Energy saving is one of the reliable means in reducing $CO_2$ emissions. If the most energy efficient technologies available at this point in time were introduced worldwide, particularly in developing countries that are expected to experience significant economic growth, $CO_2$ emissions would be reduced significantly.

**Figure 4-14 Efficiencies of thermal power generation facilities worldwide**




Source of Japanese data: Outline of Electric Power Demand-Supply, Ministry of Economy, Trade and Industry (Agency for Natural Resources and Energy)
Source of other data: Energy Balances of Non-OECD Countries, IEA

DATA 083 | **Figure 4-14 Efficiencies of thermal power generation facilities worldwide**

In order to deal with the issues concerning natural resource, energy and global environmental problems a reduction in the use of fossil fuels is necessary. Energy efficiency in Japan is superior compared to that of China, India, Asia and the world average.

A trial calculation was made for the reduction of fuel consumption and $CO_2$ emission on the assumption that the most efficient Japanese power generation technology were introduced worldwide in thermal power generation.

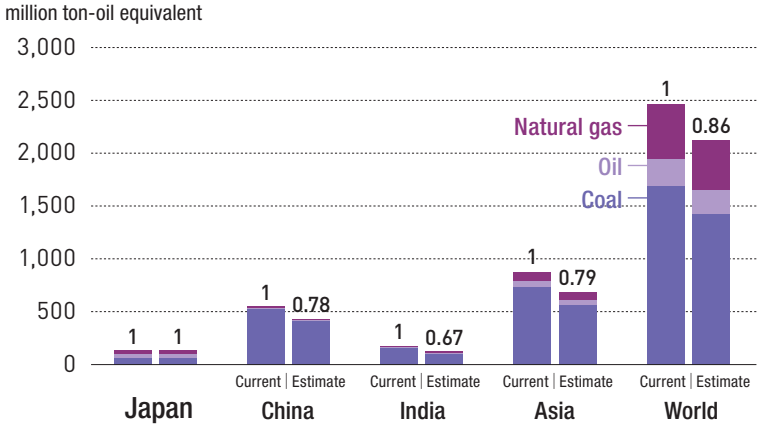
DATA 084 | **Figure 4-15 Fuel consumption, assuming power generation efficiency equivalent to Japan were achieved**

In case power generation efficiency equivalent to Japan were achieved worldwide, current fuel consumption would be reduced by 14%.

**Figure 4-16 $CO_2$ emission from power generation, assuming power generation efficiency equivalent to Japan were achieved**

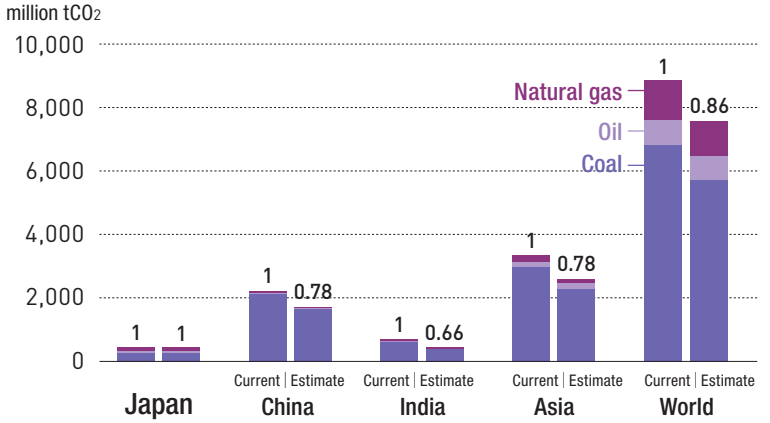
Similarly to fuel consumption, $CO_2$ emission from power generation would also be reduced by 14%, if power generation efficiency equivalent to Japan were achieved worldwide.

**Figure 4-15 Fuel consumption, assuming power generation efficiency equivalent to Japan were achieved**




Note: Concerning all countries/regions in the figure, the bar graph to the left indicates the current consumption of power generation fuels, while the bar graph to the right shows the estimated consumption of power generation fuels on the assumption that a level of efficiency equal to that of Japan has been achieved.
Source of Japanese data: Outline of Electric Power Demand-Supply, Ministry of Economy, Trade and Industry (Agency for Natural Resources and Energy)
Source of other data: Energy Balances of Non-OECD Countries, IEA

**Figure 4-16 $CO_2$ emission from power generation, assuming power generation efficiency equivalent to Japan were achieved**




Note: Concerning all countries/regions in the figure, the bar graph to the left indicates the current power generation-induced $CO_2$ emissions, while the bar graph to the right shows the estimate of power generation-induced $CO_2$ emissions based on the assumption that a level of efficiency equal to that of Japan has been achieved.
Source of Japanese data: Outline of Electric Power Demand-Supply, Ministry of Economy, Trade and Industry (Agency for Natural Resources and Energy)
Source of other data: Energy Balances of Non-OECD Countries, IEA

The use of advanced energy-saving technologies will enable further $CO_2$ emission reduction even in the steel industry.

DATA 085 | **Figure 4-17 Comparison of efficiency in the steel industry by country (2005)**

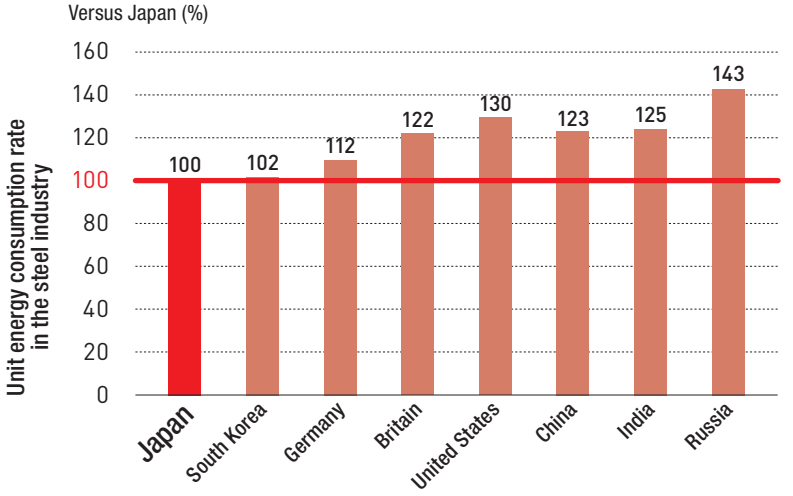
According to a trial calculation undertaken by Nippon Keidanren, the steel industry in Japan is more energy efficient than those in the United States, EU, China and other countries.

**Figure 4-18 Potential $CO_2$ reduction with the use of current BAT* in the steel industry (as of 2020)**

Using the BAT, countries can reduce their $CO_2$ emissions. If coke dry quenching (CDQ), top pressure recovery turbine (TRT), exhaust heat recovery and continuous casting technologies were introduced worldwide as extensively as they have been in Japan, a reduction of nearly 300 million t$CO_2$ of emission is calculated to be potentially achievable annually worldwide. The potential reduction is estimated to be the largest in China with 140 million t$CO_2$ because while there will be an increase in production, the rate of introduction of BAT currently remains low. By technology, the amount of energy saved is the largest in coke dry quenching (CDQ) equipment at present, but depending on how extensively the technologies will be introduced, TRT and converter gas recovery may also become effective.

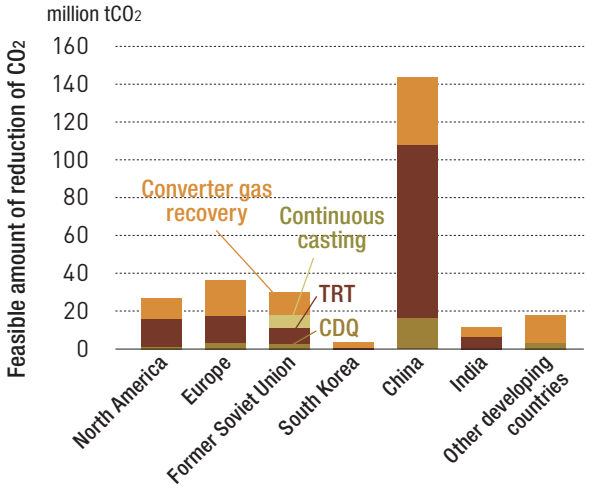
*BAT: Abbreviation for "best available technology"

**Figure 4-17 Comparison of efficiency in the steel industry by country (2005)**




Source: Results of the Fiscal 2009 Follow-up to the Keidanren Voluntary Action Plan on the Environment (Section on Global Warming Measures), Nippon Keidanren

**Figure 4-18 Potential $CO_2$ reduction with the use of current BAT in the steel industry (as of 2020)**




[Formula]
Amount of reduction in $CO_2$ emissions worldwide as of 2020 = Σ [Energy saving rate × Amount of production in 2020 × (Target extension rate – Current extension rate) × Amount of $CO_2$ emissions per energy consumption]

We referred to the projected GDP increase rate and estimated the rate of the increase in production, which was then multiplied by the production amount in 2004 to find the projected production amount.

Source: Documents distributed at the 10th meeting of the Expert Committee to Study Future Framework, Global Environment Subcommittee, Environment Committee, Industrial Structure Council

The use of advanced energy-saving technologies can reduce $CO_2$ emissions in the cement industry even further.

DATA 086 | **Figure 4-19 Efficiency in the cement manufacturing industry by country (2003)**

Cement manufacturers in Japan are more energy-efficient than those in the United States, EU, China and all other countries.

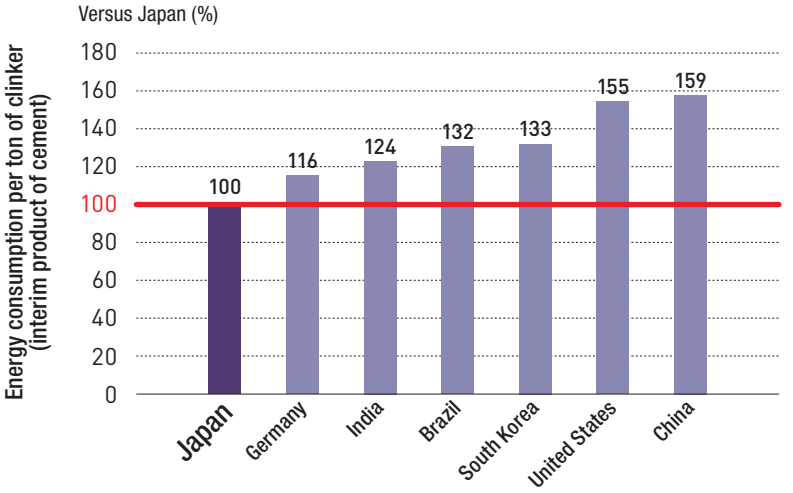
**Figure 4-20 Potential $CO_2$ reduction with the use of current BAT in the cement manufacturing industry (as of 2020)**

Using BAT countries could further reduce $CO_2$ emissions. If other countries successfully reduced their emission rates to a level equal to that of Japan, a reduction of 16% of global emission of 2.9 billion $tCO_2$, namely approx. 600 million $tCO_2$ of emission reduction would be achieved worldwide. The absolute amount of reduction will be 300 million $tCO_2$ in China, a country with a large amount of production. It is equal to 53% of the total potential $CO_2$ emission reduction.



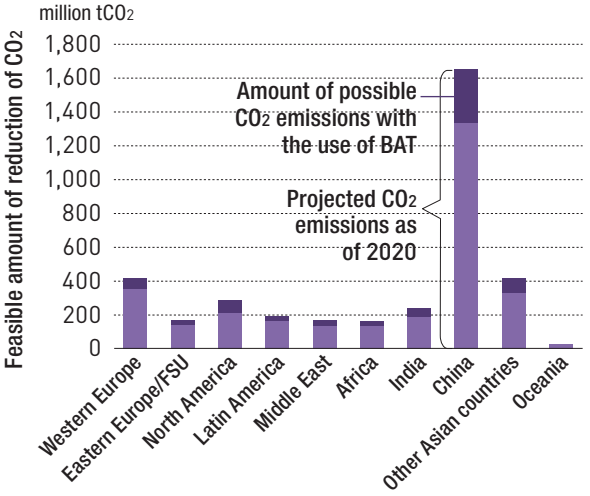


**Figure 4-19 Efficiency in the cement manufacturing industry by country (2003)**




Source: Results of the Fiscal 2009 Follow-up to the Keidanren Voluntary Action Plan on the Environment (Section on Global Warming Measures), Nippon Keidanren

**Figure 4-20 Potential $CO_2$ reduction with the use of current BAT in the cement manufacturing industry (as of 2020)**




[Formula]
Feasible amount of reduction in $CO_2$ emissions worldwide as of 2020 = Projected amount of production in 2020 × (Current $CO_2$ emission rate worldwide – Emission rate in Japan)

We referred to the projected GDP increase rate and estimated the rate of the increase in production, which was then multiplied by the production amount in 2004 to find the projected production amount.

Source: Documents distributed at the 10th meeting of the Expert Committee to Study Future Framework, Global Environment Subcommittee, Environment Committee, Industrial Structure Council

Similar trial calculations for passenger cars are made. Comparisons in $CO_2$ emissions depending on the means of transportation should be useful in considering which means of transportation to choose for various applications in the future.

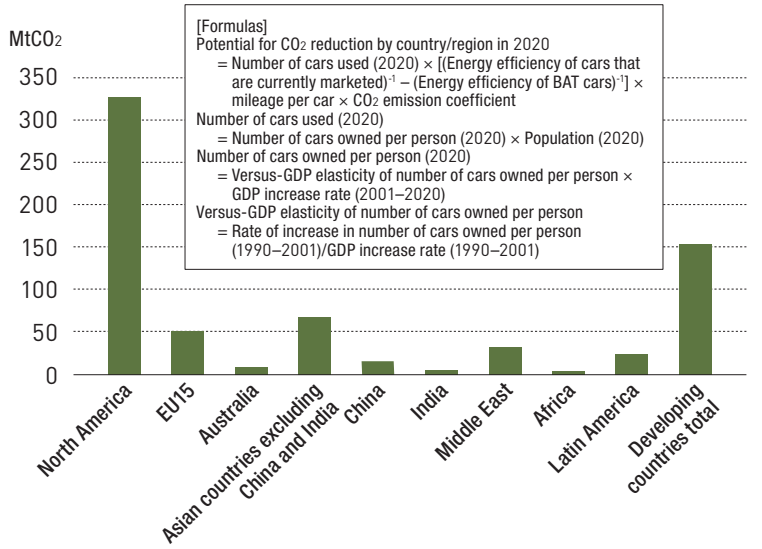
DATA 087 | **Figure 4-21 Potential $CO_2$ reduction with the use of current BAT in passenger cars (as of 2020)**

If fuel efficiency increased in other countries to a level equal to that of Japan, the potential in reduction in North America could be greater than that in developing countries (because of the huge number of cars used and with many of them being fuel inefficient). It is expected that reasonably priced used cars (less fuel-efficient) would be used more in developing countries than in developed countries.

**Figure 4-22 Comparison of $CO_2$ emissions by means of transportation (2005)**

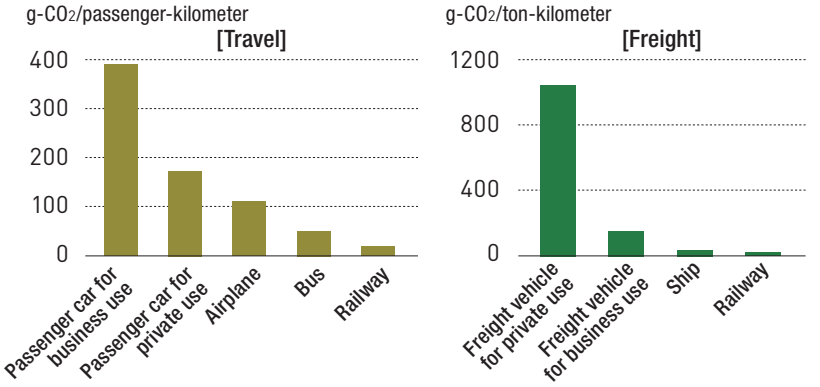
In the travel sector, while the emission rate per person per distance is high for passenger cars which are regarded highly convenient, the emission rates for buses, railway and others having mass transportation capacity and used in public transportation are low. In the freight sector, the emission rates of railways and ships are much lower than that for freight vehicles. These results suggest that using public transportation or mass transportation systems would be effective in reducing $CO_2$ emissions in the transportation sector.

**Figure 4-21 Potential $CO_2$ reduction with the use of current BAT in passenger cars (as of 2020)**




Source: Documents distributed at the 10th meeting of the Expert Committee to Study Future Framework, Global Environment Subcommittee, Environment Committee, Industrial Structure Council

**Figure 4-22 Comparison of $CO_2$ emissions by means of transportation (2005)**
**(Left: travel, right: freight)**




Source: Website of the Ministry of Land, Infrastructure, Transport and Tourism

In order to deal with the global warming problems, there is a demand to accelerate the development of new technologies.
The technology examples shown in Cool Earth—Innovative Energy Technology and in technologies supporting Recycling-Oriented Society enables us to see the overall picture of the technologies required to overcome global environmental problems. They are also useful in understanding what kind of technologies are studied individually for specific purposes.





**Table 1 Cool Earth—Examples of innovative technologies specified in the Innovative Energy Technology Plan**

| Area/Technology | Description | Problem |
|---|---|---|
| **Technologies of coal and other fossil fuels** | | |
| **Integrated coal gasification combined cycle (IGCC)** | This is a technology for enhancing power generation efficiency by converting coal into high-temperature gas, turning the gas turbine and using the exhaust heat to turn the steam turbine.<br>The efficiency of its power generation is projected to rise by almost 20% (the current efficiency of coal-fired thermal power, about 41%, will improve to 48%) by around 2015. $CO_2$ emissions will also decrease by around 20%. | Issues such as reliability of its long-term operations a common requirement in commercially available machines, economic efficiency, securing operational safety need and establishing oxygen-blowing gasification technology needs to be resolved prior to its practical application. |
| **Integrated coal gasification fuel cell combined cycle (IGFC)** | This is a technology for generating power by gasifying coal and operating the gas turbine and the steam turbine, and for enhancing the efficiency of power generation by capturing the hydrogen contained in the gas and utilizing it in fuel cells.<br>Enhancing the power generation efficiency by nearly 30%, from the current 41% to 55%, would reduce $CO_2$ emissions by nearly 30% in comparison with the current coal-fired thermal power generation. | Establishing a technology to produce oxygen which is necessary for coal gasification more efficiently and at a lower cost, larger fuel cell development and to verify the reliability of the IGFC system are needed. |
| **Carbon dioxide capture and storage (CCS)** | This is a technology to separate and recover carbon dioxide from the exhaust gas generated from the combustion of fossil fuels in large-scale emission sources such as thermal power generation at a low cost and then to store it underground stably. The amount of $CO_2$ emissions becomes almost zero.<br>Technological development to ensure efficient and low-cost capturing is the key. The storage technology has been proven in oil and natural gas fields around the world. | According to a report by IPCC, the additional energy required for CCS if CCS is added to a power plant is said to range between 10% and 40% of the energy requirement without CCS. Much of the energy is required in the capturing of $CO_2$.<br>High-efficiency capturing technology needs to be developed in the future (e.g. development of separation membranes and new absorbents).<br>Verifying elemental technologies by integrated demonstration test as well as upgrading monitoring technologies to confirm the stability of the storage are necessary. |

| Area/Technology | Description | Problem |
|---|---|---|
| **New energy technologies (supply side)** | | |
| **Innovative photovoltaic power generation** | A low-cost, highly efficient solar cell technology involving the use of new materials like organic materials and a new structure like quantum dots (with particles arranged in a grid-like form in nanometer scale structure).<br>Power generation efficiency, currently 10%–15%, will drastically improve to more than 40%. The current cost of photovoltaic power generation (46 yen/kWh) will be lowered to a level equal to that of thermal power generation (7 yen/kWh). | Further improvement in the efficiency of converting light to electricity by utilizing new materials and new structures. Thoroughly pursuing mass production and cost reduction through the utilization of materials alternative to silicone. |
| **Technology for the production of cellulosic biomass fuels etc.** | This is a technology for efficiently producing bioethanol from cellulosic biomass that does not compete against food, with the use of enzymes, etc.<br>Being plant-derived, this type of fuel is regarded as carbon-neutral (does not cause $CO_2$ to increase). | The efficient pre-treatment of cellulosic biomass and the development of glycation technologies, etc. are required to ensure that bioethanol is produced at a low cost without competing against food. |
| **Technologies of nuclear power generation, electricity etc.** | | |
| **Fast reactor**<br>**Next-generation light-water reactor**<br>**Medium- and small-sized reactors** | With the use of fast neutrons, the technology of the fast reactor cycle dramatically improves efficiency in the use of uranium resources and drastically reduces radioactive waste.<br>The technology of the next-generation large-sized light-water reactor has significantly improved economic efficiency, reliability and safety by, for example, introducing seismic isolation technologies and high burnt-up fuels for the purpose of meeting the demand for alternatives to domestic and overseas nuclear reactors that is expected to arise around 2030.<br>Small- and medium-sized reactors can satisfy the demand for small- and medium-sized power generation systems in developing countries, island states etc. | Technological difficulties in achieving greater economic efficiency than that of current nuclear reactors and in enhancing the reliability and safety of reactors so as to facilitate their long-term, stable operation need to be addressed. |



| Area/Technology | Description | Problem |
|---|---|---|
| **Energy-saving technologies** | | |
| **Innovative steel manufacturing process** | A steel manufacturing technology using hydrogen as a reducing agent to partially replace coke (carbon).<br>For example, $CO_2$ emissions from the steel sector were almost 7% of the world total in 2004. According to some trial calculations, if steel manufacturing technology using hydrogen as a reducing agent and a technology for separating and capturing $CO_2$ were established, $CO_2$ emission would be reduced by around 30%. | A technology in developing a catalyst to efficiently produce hydrogen from coke-oven gas by utilizing the unused exhaust heat of approx. 800 degrees in the coke oven and a reaction control technology in reducing iron ore utilizing hydrogen need to be developed. |
| **New energy technologies (user side)** | | |
| **Fuel cell automobiles**<br>**Storage materials and other hydrogen-related technologies** | Fuel cell technology using a new material replacing platinum and an electrolyte membrane to realize low-cost/high-efficiency so as to increase the use of fuel cells in automobiles etc.<br>A hydrogen storage technology using alloy and other materials to efficiently store and transport hydrogen that is indispensable for the full-scale practical use and extension of fuel cell automobiles. The technologies will increase the on-board hydrogen storage capacity of a fuel cell automobile and enable it to drive a distance equivalent to that of current automobiles (around 800 kilometers). $CO_2$ emissions could be reduced to nearly one-third of those of gasoline-powered vehicles. | Continued reduction of costs and improvement in durability is required. This requires the development of electrolyte membrane, catalyst replacing platinum and a separator. Concerning the storage of hydrogen, technical breakthroughs are needed in areas such as dealing with the shift to high pressure (700 atmospheres), and a drastic improvement in hydrogen storage capacity by resolving the basic principles in metallic hydrogen storage materials. |
| **High-performance storage batteries (electric cars etc.)** | Plug-in hybrid cars are hybrid cars that can be charged from external power sources such as those available in the home. According to some trial calculations, introduction of this type of a car helps reduce gasoline consumption by 30%–70%. The utilization of nighttime power facilitates greater energy savings and reduction in environmental load.<br>Electric cars are driven by electrical motors alone and consume no gasoline and their $CO_2$ emissions are a quarter of those of gasoline-powered cars. The development of high-performance storage batteries will hopefully help extend the driving distance per charge to 500 kilometers. | A new type of battery needs to be developed, and it should be based on a totally different concept from that of existing lithium batteries to dramatically extend the driving distance per charge.<br>The development of alternative materials is needed to boost the motor output and trim its weight. |

The table was created by Mitsubishi Research Institute, Inc. in accordance with the Cool Earth—Innovative Energy Technology Program.

## Table 2 Technology examples supporting a recycling-oriented society

| Area/Technology | Description |
|---|---|
| **Recycling of water** | |
| **Treatment and recycling of industrial effluent** | Numerous different technologies are used to treat industrial effluent, depending on its quantity and quality. Inorganic wastewater treatment generally involves separation cleaning by chemical agent electrification and electrolysis and membrane filtration. Organic wastewater treatment involves treatment by activated sludge, membrane treatment (MBR, biological separation membrane etc.), micro-bubbles, ozone treatment, addition of microbial chemicals and oily water separation. Although the technologies used for treatment and recycling of industrial effluent are mostly established, membrane treatment in particular is expected to undergo technological improvements in the coming years. From the viewpoint of CSR or in constructing plants in regions that are poor in terms of water resources, technology for recycling industrial effluent and a process that discharges no wastewater outside the plant have attracted attention. |
| **Water for miscellaneous uses** | Utilization of water for miscellaneous uses which involve encouraging the use of recyclable water (e.g. sewage, industrial effluent) and rainwater etc. for flushing toilets, landscaping, sprinkling and other applications are promoted by the national government and municipal governments. The system for using this kind of water is divided into recycling of wastewater and the use of rainwater. The introduction of (non-cyclic) rainwater use has advanced in recent years. The system of water for miscellaneous uses often depends on the combination of existing water treatment technologies, although it differs between the types of water sources. |
| **Purification of environmental waters** | The scope of the purification of environmental waters includes technology for the removal of pollution from small areas of water (e.g. reservoirs, ponds and moats in parks), rivers, lakes, marshes, groundwater, seas, dams and the like. The purification efforts contribute to the removal of organic substances and nutrient salts and the improvement of clarity. In particular, technologies for the removal of many organic substances and nutrient salts for the prevention of eutrophication have been developed and verified in closed water areas such as rivers, lakes and marshes. |
| **Recycling of wastes** | |
| **Rare metal recycling** | As competition to obtain resources intensifies, the importance of recycling rare metals from manufactured goods is growing. In Japan, the Special Subcommittee for Comprehensive Measures on Rare Metals of the Mining Industry Council (Ministry of Economy, Trade and Industry) designates 31 types of mineral as rare metals (rare earth is regarded as one type of mineral that includes 17 different types of mineral). Government stockpiling applies to seven types of rare metal: manganese, vanadium, nickel, tungsten, cobalt, chromium and molybdenum. Rare metals are used in catalysts and special steel for automobiles, carbide tools, batteries, electronic substrates and other products. Recycling technologies have been developed on a product basis. |



| Area/Technology | Description |
|---|---|
| **Use of recycled materials as building material** | With the aim of reducing the amount of final waste disposal of construction waste and facilitating the efficient use of incinerated residue from waste disposal, technologies for recycling these materials for use as building material are being developed. After the enactment of the Construction Waste Recycling Law, the market for recycled building materials is expected to grow. Among the production technologies associated to recycled building materials there are those that utilize non-construction wastes such as recycling of office carpets, water-permeable block production using incinerated ash from sewage sludge and glass waste, conversion of incinerated ash into eco-friendly cement and interior materials made of plastic waste. Introducing these technologies involves difficulties in terms of manufacturing costs and the limited range of use. In that regard, technological developments must continue. |
| **Nature regeneration** | |
| **Technology for nature regeneration** | The natural environment is rapidly deteriorating in recent years due to destruction of nature through land development, abandonment of the management of village-vicinity land and mountains and disturbance of ecosystems by migration of alien species. In such circumstances, nature regeneration is directly aimed at restoring the health of ecosystems by proactively reinstating the nature that was lost in the past, rather than alternating nature as a supplement to acts of development. The basis of nature regeneration is to develop a variety of ecosystems by designating some parts of surrounding areas as the land for regeneration while conserving the better part of nature that exists. Nature regeneration is largely divided into two parts: active regeneration and passive regeneration. Active regeneration is a proactive, rapid-acting approach taken by humans raising trees and plants after geomorphic development and soil improvement are completed. In passive regeneration, humankind undertakes geomorphic development and other activities to maintain environmental conditions, and leaves the rest to heal naturally through plant succession. |
| **Biotopes** | A biotope is a space inhabited by organically connected biological community that is differentiated from the surroundings. More simply, it is a space inhabited by wildlife. Recently, the interpretation of the word “biotope” has transcended its original ecological meaning: it is also recognized as a place where people and nature can coexist while maintaining the living environment of wildlife. The meaning of the word has now expanded to include biotopes in small ponds and brooks at schools that are intended for inhabitation by dragonflies and fireflies; biotopes created on the rooftops of buildings; and larger biotopes by networking biotopes surrounding the rivers, moors, forests, mudflats and the like. Sprinkling and surface soil methods (e.g. the vegetation sandbag method) are utilized to create biotopes. |

Created by Mitsubishi Research Institute, Inc. based on a number of related documents

# Appendix: Statistical Data



## Document 1-1 | Changes in population | By region

Source: World Population Prospects: The 2008 Revision, UN

| By region | Population (July 1) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950 | 1955 | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 (projection) |
| Africa | 227,270 | 253,397 | 285,049 | 322,309 | 366,792 | 418,765 | 482,236 | 556,131 | 638,729 | 726,285 | 819,462 | 921,073 | 1,033,043 |
| Asia | 1,402,887 | 1,541,775 | 1,693,992 | 1,885,955 | 2,125,393 | 2,379,374 | 2,622,565 | 2,889,608 | 3,178,810 | 3,448,034 | 3,698,296 | 3,936,536 | 4,166,741 |
| Europe | 547,460 | 575,466 | 604,464 | 634,191 | 656,197 | 676,207 | 693,113 | 706,988 | 720,989 | 727,361 | 726,568 | 729,421 | 732,759 |
| Latin America | 167,307 | 191,596 | 219,651 | 252,204 | 286,472 | 323,323 | 362,655 | 402,103 | 442,310 | 482,265 | 521,228 | 556,512 | 588,649 |
| North America | 171,615 | 186,960 | 204,318 | 219,224 | 231,284 | 242,360 | 254,097 | 266,572 | 282,688 | 300,073 | 318,654 | 335,175 | 351,659 |
| Oceania | 12,807 | 14,260 | 15,884 | 17,788 | 19,639 | 21,286 | 22,943 | 24,845 | 26,926 | 29,054 | 31,160 | 33,559 | 35,838 |

## Document 1-1 | Changes in population | By income level

Source: World Population Prospects: The 2008 Revision, UN

| By income level | Population (July 1) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950 | 1955 | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 (projection) |
| World total | 2,529,346 | 2,763,453 | 3,023,358 | 3,331,670 | 3,685,777 | 4,061,317 | 4,437,609 | 4,846,247 | 5,290,452 | 5,713,073 | 6,115,367 | 6,512,276 | 6,908,688 |
| Developed countries | 812,026 | 862,810 | 914,618 | 965,620 | 1,007,477 | 1,046,894 | 1,081,847 | 1,113,543 | 1,147,345 | 1,174,680 | 1,194,967 | 1,216,550 | 1,237,228 |
| Developing countries | 1,717,320 | 1,900,643 | 2,108,740 | 2,366,050 | 2,678,300 | 3,014,422 | 3,355,762 | 3,732,705 | 4,143,107 | 4,538,393 | 4,920,400 | 5,295,726 | 5,671,460 |
| Least less developed countries | 200,461 | 221,657 | 247,268 | 277,753 | 314,813 | 357,413 | 405,847 | 461,088 | 524,764 | 599,098 | 676,929 | 761,846 | 854,696 |
| Developing countries except LLDCs | 1,516,859 | 1,678,986 | 1,861,471 | 2,088,297 | 2,363,487 | 2,657,009 | 2,949,915 | 3,271,617 | 3,618,343 | 3,939,294 | 4,243,472 | 4,533,880 | 4,816,763 |
| Developing countries except China | 1,170,205 | 1,299,746 | 1,459,565 | 1,645,879 | 1,858,153 | 2,098,607 | 2,369,543 | 2,673,723 | 2,994,940 | 3,320,798 | 3,646,339 | 3,976,103 | 4,309,697 |
| Sub-Saharan Africa | 183,478 | 204,165 | 229,222 | 259,186 | 294,963 | 337,635 | 389,754 | 449,716 | 518,053 | 593,183 | 674,842 | 764,328 | 863,314 |

## Document 1-2 | Changes in population | By country, 10 million people or more

Source: World Population Prospects: The 2008 Revision, UN

| | Population (July 1) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950 | 1955 | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 (projection) |
| **World total** | 2,529,346 | 2,763,453 | 3,023,358 | 3,331,670 | 3,685,777 | 4,061,317 | 4,437,609 | 4,846,247 | 5,290,452 | 5,713,073 | 6,115,367 | 6,512,276 | 6,908,688 |

| | Population (July 1) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950 | 1955 | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 (projection) |
| **Africa** | 227,270 | 253,397 | 285,049 | 322,309 | 366,792 | 418,765 | 482,236 | 556,131 | 638,729 | 726,285 | 819,462 | 921,073 | 1,033,043 |
| **Eastern Africa** | 64,847 | 72,585 | 81,999 | 93,589 | 107,606 | 124,044 | 143,492 | 165,962 | 192,959 | 219,874 | 252,710 | 287,413 | 327,186 |
| Ethiopia | 18,434 | 20,297 | 22,550 | 25,473 | 28,948 | 32,945 | 35,409 | 41,049 | 48,292 | 56,983 | 65,515 | 74,661 | 84,976 |
| United Republic of Tanzania | 7,650 | 8,741 | 10,073 | 11,680 | 13,600 | 15,972 | 18,661 | 21,811 | 25,455 | 29,972 | 34,131 | 39,007 | 45,040 |
| Kenya | 6,077 | 6,979 | 8,104 | 9,502 | 11,249 | 13,481 | 16,261 | 19,648 | 23,433 | 27,492 | 31,441 | 35,817 | 40,863 |
| Uganda | 5,158 | 5,899 | 6,787 | 8,013 | 9,443 | 10,893 | 12,655 | 14,795 | 17,731 | 20,954 | 24,433 | 28,699 | 33,796 |
| Mozambique | 6,442 | 6,972 | 7,646 | 8,471 | 9,449 | 10,614 | 12,138 | 13,324 | 13,543 | 15,945 | 18,249 | 20,834 | 23,406 |
| Madagascar | 4,084 | 4,547 | 5,103 | 5,763 | 6,546 | 7,498 | 8,604 | 9,778 | 11,273 | 13,121 | 15,275 | 17,614 | 20,146 |
| Malawi | 2,881 | 3,169 | 3,529 | 3,975 | 4,518 | 5,276 | 6,215 | 7,267 | 9,451 | 10,144 | 11,831 | 13,654 | 15,692 |
| Zambia | 2,340 | 2,653 | 3,044 | 3,536 | 4,138 | 4,899 | 5,774 | 6,785 | 7,910 | 9,108 | 10,467 | 11,738 | 13,257 |
| Zimbabwe | 2,747 | 3,203 | 3,751 | 4,421 | 5,204 | 6,168 | 7,282 | 8,845 | 10,461 | 11,713 | 12,455 | 12,475 | 12,644 |
| Rwanda | 2,162 | 2,485 | 2,887 | 3,202 | 3,776 | 4,410 | 5,197 | 6,111 | 7,150 | 5,440 | 7,958 | 8,992 | 10,277 |
| **Middle Africa** | 26,116 | 28,767 | 32,088 | 36,003 | 40,944 | 46,712 | 53,792 | 62,411 | 72,813 | 86,424 | 98,060 | 113,185 | 128,909 |
| Democratic Republic of the Congo | 12,184 | 13,589 | 15,385 | 17,504 | 20,285 | 23,433 | 27,170 | 31,402 | 37,016 | 44,921 | 50,829 | 59,077 | 67,827 |
| Cameroon | 4,466 | 4,900 | 5,408 | 6,047 | 6,839 | 7,826 | 9,080 | 10,509 | 12,233 | 14,054 | 15,865 | 17,823 | 19,958 |
| Angola | 4,148 | 4,531 | 5,012 | 5,505 | 6,083 | 6,815 | 7,854 | 9,331 | 10,661 | 12,539 | 14,280 | 16,618 | 18,993 |
| Chad | 2,429 | 2,677 | 2,967 | 3,308 | 3,682 | 4,155 | 4,608 | 5,222 | 6,105 | 7,128 | 8,402 | 10,019 | 11,506 |
| **Northern Africa** | 52,982 | 59,565 | 67,510 | 76,337 | 86,868 | 98,624 | 112,991 | 130,467 | 147,767 | 163,943 | 179,525 | 195,444 | 212,921 |
| Egypt | 21,514 | 24,378 | 27,798 | 31,573 | 35,575 | 39,599 | 44,433 | 50,655 | 57,785 | 63,858 | 70,174 | 77,154 | 84,474 |
| Sudan | 9,190 | 10,333 | 11,683 | 13,214 | 15,039 | 17,493 | 20,509 | 24,052 | 27,091 | 30,841 | 34,904 | 38,698 | 43,192 |
| Algeria | 8,753 | 9,715 | 10,800 | 11,923 | 13,746 | 16,018 | 18,811 | 22,097 | 25,283 | 28,265 | 30,506 | 32,855 | 35,423 |
| Morocco | 8,953 | 10,132 | 11,626 | 13,323 | 15,310 | 17,305 | 19,567 | 22,299 | 24,808 | 26,951 | 28,827 | 30,495 | 32,381 |
| Tunisia | 3,530 | 3,860 | 4,221 | 4,630 | 5,127 | 5,668 | 6,457 | 7,330 | 8,215 | 8,935 | 9,452 | 9,878 | 10,374 |
| **Southern Africa** | 15,588 | 17,487 | 19,723 | 22,417 | 25,453 | 29,088 | 32,973 | 37,450 | 41,980 | 47,240 | 51,387 | 55,041 | 57,968 |
| South Africa | 13,683 | 15,385 | 17,396 | 19,814 | 22,502 | 25,698 | 29,075 | 32,959 | 36,745 | 41,375 | 44,872 | 48,073 | 50,492 |
| **Western Africa** | 67,736 | 74,993 | 83,728 | 93,964 | 105,920 | 120,298 | 138,988 | 159,841 | 183,210 | 208,805 | 237,781 | 269,990 | 306,058 |
| Nigeria | 36,680 | 40,610 | 45,148 | 50,414 | 56,467 | 63,948 | 74,523 | 85,151 | 97,338 | 110,449 | 124,842 | 140,879 | 158,259 |
| Ghana | 4,981 | 5,792 | 6,789 | 7,853 | 8,739 | 10,001 | 11,026 | 13,006 | 14,968 | 17,245 | 19,529 | 21,915 | 24,333 |
| Côte d'Ivoire | 2,505 | 2,907 | 3,445 | 4,224 | 5,233 | 6,621 | 8,419 | 10,476 | 12,610 | 14,981 | 17,281 | 19,245 | 21,571 |
| Burkina Faso | 4,080 | 4,363 | 4,721 | 5,116 | 5,608 | 6,173 | 6,862 | 7,704 | 8,814 | 10,127 | 11,676 | 13,747 | 16,287 |
| Niger | 2,462 | 2,825 | 3,242 | 3,766 | 4,383 | 5,090 | 5,922 | 6,827 | 7,904 | 9,302 | 11,031 | 13,102 | 15,891 |
| Mali | 4,268 | 4,621 | 5,060 | 5,525 | 6,036 | 6,598 | 7,183 | 7,858 | 8,655 | 9,549 | 10,523 | 11,833 | 13,323 |
| Senegal | 2,416 | 2,697 | 3,082 | 3,550 | 4,169 | 4,888 | 5,636 | 6,514 | 7,538 | 8,660 | 9,902 | 11,281 | 12,861 |
| Guinea | 2,619 | 2,850 | 3,123 | 3,453 | 3,843 | 4,037 | 4,628 | 5,267 | 6,147 | 7,478 | 8,384 | 9,221 | 10,324 |
| **Asia** | 1,402,887 | 1,541,775 | 1,693,992 | 1,885,955 | 2,125,393 | 2,379,374 | 2,622,565 | 2,889,608 | 3,178,810 | 3,448,034 | 3,698,296 | 3,936,536 | 4,166,741 |
| Eastern Asia | 659,649 | 721,594 | 779,337 | 860,030 | 971,537 | 1,079,675 | 1,159,375 | 1,241,025 | 1,336,700 | 1,411,675 | 1,472,444 | 1,520,717 | 1,563,951 |
| China | 544,951 | 598,226 | 645,927 | 716,270 | 815,951 | 911,167 | 980,929 | 1,053,219 | 1,142,090 | 1,210,969 | 1,266,954 | 1,312,253 | 1,354,146 |
| Japan | 82,824 | 89,047 | 93,189 | 98,052 | 104,448 | 111,619 | 116,794 | 120,908 | 123,191 | 125,442 | 126,706 | 127,449 | 126,995 |
| Republic of Korea | 19,211 | 21,168 | 25,068 | 28,390 | 31,440 | 34,721 | 37,459 | 40,505 | 42,983 | 44,651 | 46,429 | 47,566 | 48,501 |
| Dem. People's Republic of Korea | 9,737 | 9,632 | 10,946 | 12,323 | 14,247 | 16,072 | 17,239 | 18,721 | 20,143 | 21,717 | 22,859 | 23,529 | 23,991 |
| **South-Central Asia** | 515,809 | 565,918 | 626,984 | 698,981 | 782,547 | 879,410 | 990,929 | 1,116,346 | 1,250,453 | 1,385,935 | 1,518,322 | 1,650,635 | 1,780,473 |
| India | 371,857 | 406,661 | 448,314 | 496,934 | 552,964 | 617,432 | 692,637 | 774,775 | 862,162 | 953,148 | 1,042,590 | 1,130,618 | 1,214,464 |
| Pakistan | 41,177 | 44,499 | 48,778 | 54,267 | 61,750 | 71,238 | 82,609 | 98,309 | 115,776 | 130,397 | 148,132 | 165,816 | 184,753 |
| Bangladesh | 43,595 | 48,442 | 54,138 | 60,931 | 69,178 | 79,049 | 90,397 | 102,993 | 115,632 | 128,086 | 140,767 | 153,122 | 164,425 |
| Iran (Islamic Republic of) | 16,913 | 19,090 | 21,704 | 24,886 | 28,805 | 33,344 | 39,330 | 48,418 | 56,733 | 62,205 | 66,903 | 70,765 | 75,078 |
| Nepal | 8,126 | 8,864 | 9,691 | 10,677 | 11,893 | 13,356 | 15,058 | 16,962 | 19,105 | 21,624 | 24,432 | 27,222 | 29,853 |
| Afghanistan | 8,151 | 8,805 | 9,616 | 10,612 | 11,840 | 13,329 | 13,946 | 12,293 | 12,580 | 18,084 | 20,536 | 24,507 | 29,117 |
| Uzbekistan | 6,314 | 7,256 | 8,559 | 10,234 | 11,973 | 13,981 | 15,952 | 18,174 | 20,515 | 22,919 | 24,776 | 26,320 | 27,794 |
| Sri Lanka | 8,241 | 8,983 | 10,018 | 11,192 | 12,520 | 13,790 | 15,060 | 16,168 | 17,290 | 18,233 | 18,767 | 19,531 | 20,410 |

| | Population (July 1) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1950 | 1955 | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2010 (projection) |
| Kazakhstan | 6,703 | 7,992 | 9,996 | 11,909 | 13,110 | 14,136 | 14,919 | 15,780 | 16,530 | 15,926 | 14,957 | 15,194 | 15,753 |
| **South-Eastern Asia** | 175,905 | 195,422 | 220,395 | 249,910 | 283,267 | 318,964 | 355,774 | 398,178 | 439,591 | 479,834 | 517,193 | 554,079 | 589,615 |
| Indonesia | 77,152 | 83,856 | 93,058 | 103,978 | 116,921 | 131,329 | 146,582 | 162,348 | 177,385 | 191,501 | 205,280 | 219,210 | 232,517 |
| Philippines | 19,996 | 23,224 | 27,057 | 31,570 | 36,567 | 42,038 | 48,112 | 55,032 | 62,427 | 69,965 | 77,689 | 85,496 | 93,617 |
| Vietnam | 27,367 | 30,052 | 33,648 | 38,099 | 42,898 | 47,974 | 53,317 | 59,789 | 66,247 | 72,957 | 78,663 | 84,074 | 89,029 |
| Thailand | 20,607 | 23,799 | 27,642 | 32,195 | 37,186 | 42,236 | 47,264 | 52,545 | 56,673 | 60,140 | 62,347 | 65,946 | 68,139 |
| Myanmar | 17,158 | 18,930 | 21,075 | 23,505 | 26,403 | 29,886 | 33,561 | 37,443 | 40,844 | 43,864 | 46,610 | 48,345 | 50,496 |
| Malaysia | 6,110 | 7,000 | 8,140 | 9,502 | 10,853 | 12,258 | 13,763 | 15,677 | 18,103 | 20,594 | 23,274 | 25,633 | 27,914 |
| Cambodia | 4,346 | 4,840 | 5,433 | 6,141 | 6,938 | 7,098 | 6,748 | 8,099 | 9,690 | 11,380 | 12,760 | 13,866 | 15,053 |
| **Western Asia** | 51,524 | 58,840 | 67,276 | 77,033 | 88,042 | 101,325 | 116,487 | 134,060 | 152,066 | 170,590 | 190,336 | 211,104 | 232,702 |
| Turkey | 21,484 | 24,610 | 28,233 | 31,997 | 36,207 | 41,211 | 46,161 | 51,289 | 56,086 | 61,206 | 66,460 | 71,169 | 75,705 |
| Iraq | 5,719 | 6,634 | 7,497 | 8,637 | 10,210 | 12,016 | 14,024 | 16,093 | 18,079 | 20,971 | 24,652 | 28,238 | 31,467 |
| Saudi Arabia | 3,201 | 3,593 | 4,075 | 4,793 | 5,745 | 7,251 | 9,604 | 12,867 | 16,259 | 18,255 | 20,808 | 23,613 | 26,246 |
| Yemen | 4,316 | 4,732 | 5,222 | 5,799 | 6,391 | 7,093 | 8,381 | 10,137 | 12,314 | 15,523 | 18,182 | 21,024 | 24,256 |
| Syrian Arab Republic | 3,536 | 3,991 | 4,621 | 5,399 | 6,371 | 7,537 | 8,971 | 10,815 | 12,721 | 14,610 | 16,511 | 19,121 | 22,505 |
| **Europe** | 547,460 | 575,466 | 604,464 | 634,191 | 656,197 | 676,207 | 693,113 | 706,988 | 720,989 | 727,361 | 726,568 | 729,421 | 732,759 |
| **Eastern Europe** | 220,198 | 237,112 | 253,469 | 266,937 | 276,415 | 285,737 | 294,972 | 303,586 | 310,332 | 309,804 | 304,088 | 296,912 | 291,485 |
| Russian Federation | 102,702 | 111,402 | 119,906 | 126,749 | 130,392 | 134,233 | 138,655 | 143,541 | 148,065 | 148,497 | 146,670 | 143,170 | 140,367 |
| Ukraine | 37,298 | 40,099 | 42,783 | 45,341 | 47,317 | 49,016 | 50,044 | 50,915 | 51,583 | 51,063 | 48,870 | 46,936 | 45,433 |
| Poland | 24,824 | 27,281 | 29,638 | 31,445 | 32,664 | 34,015 | 35,574 | 37,202 | 38,111 | 38,595 | 38,433 | 38,198 | 38,038 |
| Romania | 16,311 | 17,486 | 18,407 | 19,032 | 20,253 | 21,245 | 22,201 | 22,725 | 23,207 | 22,681 | 22,138 | 21,635 | 21,190 |
| Czech Republic | 8,925 | 9,292 | 9,546 | 9,709 | 9,801 | 10,034 | 10,284 | 10,310 | 10,303 | 10,319 | 10,224 | 10,195 | 10,411 |
| **Northern Europe** | 78,093 | 79,635 | 81,762 | 84,928 | 87,357 | 89,011 | 89,877 | 90,746 | 92,121 | 93,261 | 94,359 | 96,439 | 98,909 |
| United Kingdom | 50,616 | 51,199 | 52,372 | 54,350 | 55,663 | 56,226 | 56,314 | 56,554 | 57,237 | 58,042 | 58,907 | 60,261 | 61,899 |
| **Southern Europe** | 108,259 | 113,093 | 117,379 | 122,348 | 126,782 | 132,288 | 137,765 | 140,824 | 142,549 | 143,698 | 145,119 | 149,711 | 153,778 |
| Italy | 46,367 | 48,137 | 49,511 | 51,481 | 53,359 | 55,164 | 56,307 | 56,883 | 56,998 | 57,207 | 57,116 | 58,645 | 60,098 |
| Spain | 28,009 | 29,199 | 30,455 | 32,056 | 33,779 | 35,688 | 37,527 | 38,425 | 38,839 | 39,391 | 40,264 | 43,060 | 45,317 |
| Greece | 7,566 | 7,966 | 8,333 | 8,551 | 8,793 | 9,047 | 9,643 | 9,934 | 10,161 | 10,672 | 10,942 | 11,064 | 11,183 |
| Portugal | 8,405 | 8,610 | 8,858 | 8,999 | 8,680 | 9,093 | 9,766 | 10,029 | 9,979 | 10,038 | 10,226 | 10,547 | 10,732 |
| **Western Europe** | 140,909 | 145,626 | 151,854 | 159,978 | 165,643 | 169,172 | 170,499 | 171,832 | 175,986 | 180,598 | 183,001 | 186,358 | 188,587 |
| Germany | 68,376 | 70,326 | 72,815 | 75,964 | 78,169 | 78,674 | 78,289 | 77,685 | 79,433 | 81,622 | 82,075 | 82,409 | 82,057 |
| France | 41,832 | 43,400 | 45,674 | 48,771 | 50,771 | 52,729 | 53,950 | 55,393 | 56,842 | 57,999 | 59,128 | 61,013 | 62,637 |
| Netherlands | 10,114 | 10,751 | 11,487 | 12,295 | 13,039 | 13,666 | 14,150 | 14,488 | 14,953 | 15,448 | 15,915 | 16,316 | 16,653 |
| Belgium | 8,628 | 8,862 | 9,155 | 9,451 | 9,632 | 9,779 | 9,828 | 9,816 | 9,933 | 10,084 | 10,193 | 10,415 | 10,698 |
| **South America/ Caribbean countries** | 167,307 | 191,596 | 219,651 | 252,204 | 286,472 | 323,323 | 362,655 | 402,103 | 442,310 | 482,265 | 521,228 | 556,512 | 588,649 |
| **Caribbean** | 17,132 | 18,835 | 20,771 | 23,145 | 25,426 | 27,744 | 29,860 | 32,063 | 34,384 | 36,640 | 38,650 | 40,566 | 42,312 |
| Cuba | 5,920 | 6,539 | 7,141 | 7,952 | 8,715 | 9,439 | 9,835 | 10,084 | 10,587 | 10,910 | 11,087 | 11,193 | 11,204 |
| Dominican Republic | 2,427 | 2,834 | 3,349 | 3,951 | 4,597 | 5,261 | 5,927 | 6,637 | 7,374 | 8,124 | 8,830 | 9,533 | 10,225 |
| Haiti | 3,221 | 3,516 | 3,869 | 4,275 | 4,713 | 5,144 | 5,691 | 6,385 | 7,108 | 7,861 | 8,648 | 9,410 | 10,188 |
| **Central America** | 37,764 | 43,721 | 51,156 | 59,820 | 69,615 | 80,687 | 91,878 | 101,687 | 112,363 | 124,004 | 135,171 | 144,288 | 153,115 |
| Mexico | 27,741 | 32,257 | 37,910 | 44,429 | 51,910 | 60,430 | 68,872 | 75,765 | 83,404 | 91,650 | 99,531 | 105,330 | 110,645 |
| Guatemala | 3,146 | 3,619 | 4,141 | 4,737 | 5,420 | 6,206 | 7,016 | 7,937 | 8,910 | 10,007 | 11,231 | 12,710 | 14,377 |
| **South America** | 112,411 | 129,039 | 147,724 | 169,238 | 191,430 | 214,893 | 240,916 | 268,353 | 295,562 | 321,621 | 347,407 | 371,658 | 393,221 |
| Brazil | 53,975 | 62,887 | 72,744 | 84,331 | 95,991 | 108,127 | 121,618 | 136,149 | 149,570 | 161,692 | 174,174 | 186,075 | 195,423 |
| Colombia | 12,000 | 13,828 | 16,006 | 18,559 | 21,333 | 23,969 | 26,891 | 29,997 | 33,204 | 36,459 | 39,773 | 43,049 | 46,300 |
| Argentina | 17,150 | 18,974 | 20,685 | 22,347 | 24,003 | 26,012 | 28,154 | 30,227 | 32,498 | 34,772 | 36,939 | 38,732 | 40,666 |
| Peru | 7,632 | 8,672 | 9,932 | 11,468 | 13,195 | 15,164 | 17,328 | 19,525 | 21,776 | 23,943 | 26,004 | 27,836 | 29,496 |
| Venezuela (Bolivarian Republic of) | 5,094 | 6,230 | 7,580 | 9,096 | 10,724 | 12,740 | 15,096 | 17,323 | 19,741 | 22,092 | 24,408 | 26,726 | 29,044 |
| Chile | 6,082 | 6,766 | 7,647 | 8,651 | 9,574 | 10,419 | 11,181 | 12,111 | 13,191 | 14,410 | 15,419 | 16,297 | 17,135 |
| Ecuador | 3,387 | 3,862 | 4,440 | 5,146 | 5,972 | 6,910 | 7,964 | 9,103 | 10,278 | 11,407 | 12,310 | 13,063 | 13,775 |
| Bolivia | 2,714 | 3,006 | 3,352 | 3,748 | 4,212 | 4,759 | 5,356 | 5,966 | 6,671 | 7,484 | 8,317 | 9,182 | 10,031 |
| **North America** | 171,615 | 186,960 | 204,318 | 219,224 | 231,284 | 242,360 | 254,097 | 266,572 | 282,688 | 300,073 | 318,654 | 335,175 | 351,659 |
| United States of America | 157,813 | 171,152 | 186,326 | 199,453 | 209,464 | 219,108 | 229,469 | 240,612 | 254,865 | 270,648 | 287,842 | 302,741 | 317,641 |
| Canada | 13,737 | 15,736 | 17,909 | 19,678 | 21,717 | 23,142 | 24,516 | 25,843 | 27,701 | 29,302 | 30,687 | 32,307 | 33,890 |
| **Oceania** | 12,807 | 14,260 | 15,884 | 17,788 | 19,639 | 21,286 | 22,943 | 24,845 | 26,926 | 29,054 | 31,160 | 33,559 | 35,838 |
| Australia | 8,219 | 9,201 | 10,276 | 11,525 | 12,728 | 13,625 | 14,695 | 15,800 | 17,091 | 18,118 | 19,171 | 20,395 | 21,512 |

## Document 2-1 | Changes in GDP worldwide | By region

Source: World Development Indicators Online Database, World Bank | GDP: in U.S. dollars in 2000 (unit: 1 billion dollars)

| | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **East Asia/Pacific countries** | 853 | 1,390 | 2,281 | 2,877 | 3,618 | 4,374 | 5,682 | 6,725 | 7,638 | 9,051 | 9,502 | 10,007 | 10,254 |
| **Europe/Central Asia** | 1,916 | 2,445 | 4,070 | 4,750 | 5,574 | 6,089 | 7,921 | 8,278 | 9,550 | 10,583 | 10,947 | 11,302 | 11,427 |
| **South America/Caribbean countries** | 452 | 582 | 771 | 1,030 | 1,339 | 1,376 | 1,513 | 1,797 | 2,095 | 2,307 | 2,438 | 2,578 | 2,691 |
| **Middle East/North African countries** | 49 | 114 | 207 | 352 | 463 | 477 | 537 | 682 | 901 | 1,089 | 1,105 | 959 | 1,003 |
| **North America** | 2,715 | 3,413 | 4,000 | 4,622 | 5,542 | 6,485 | 7,601 | 8,568 | 10,493 | 11,777 | 12,114 | 12,363 | 12,488 |
| **South Asia** | 104 | 127 | 159 | 179 | 214 | 276 | 364 | 464 | 604 | 828 | 902 | 979 | 1,046 |
| **Sub-Saharan Africa** | 84 | 108 | 138 | 170 | 206 | 233 | 271 | 288 | 341 | 428 | 448 | 477 | 500 |

## Document 2-1 | Changes in GDP worldwide | By income level

Source: World Development Indicators Online Database, World Bank | GDP: in U.S. dollars in 2000 (unit: 1 billion dollars)

| | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **High-income countries (OECD)** | 5,347 | 7,080 | 10,040 | 11,822 | 14,094 | 16,061 | 19,261 | 21,289 | 24,749 | 27,310 | 28,090 | 28,765 | 28,963 |
| **High-income countries (non-OECD)** | 41 | 88 | 171 | 296 | 428 | 430 | 562 | 723 | 898 | 1,028 | 1,053 | 907 | 899 |
| **High-level middle-income countries** | 477 | 616 | 893 | 1,192 | 1,584 | 1,686 | 2,465 | 2,629 | 3,108 | 3,679 | 3,899 | 4,133 | 4,325 |
| **Low-level middle-income countries** | 268 | 349 | 465 | 609 | 776 | 1,029 | 1,450 | 1,991 | 2,656 | 3,774 | 4,130 | 4,555 | 4,899 |
| **Low-income countries** | 40 | 47 | 57 | 61 | 75 | 105 | 152 | 169 | 211 | 272 | 285 | 304 | 322 |

## Document 2-2 | Changes in GDP worldwide | By country, countries with a GDP of 20 billion dollars or greater in 2008

(10 billion dollars or greater for Sub-Saharan Africa only)
Source: World Development Indicators Online Database, World Bank

| | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **East Asia/Pacific countries** | | | | | | | | | | | | | |
| Japan | 669.8 | 1,047.7 | 1,809.9 | 2,259.9 | 2,800.6 | 3,261.8 | 4,122.3 | 4,445.4 | 4,667.4 | 4,979.5 | 5,098.9 | 5,206.0 | 5,169.6 |
| China | 70.3 | 71.6 | 100.1 | 133.4 | 182.9 | 304.5 | 444.6 | 792.8 | 1,198.5 | 1,893.4 | 2,113.0 | 2,387.7 | 2,602.6 |
| Korea, Rep. | 28.9 | 38.5 | 63.6 | 91.6 | 128.0 | 186.6 | 295.6 | 430.5 | 533.4 | 664.4 | 698.8 | 734.5 | 750.8 |
| Australia | | 119.0 | 156.1 | 182.5 | 210.2 | 241.3 | 292.6 | 327.6 | 405.1 | 472.8 | 487.0 | 503.0 | 521.5 |
| Indonesia | 18.4 | 20.4 | 27.6 | 40.2 | 58.8 | 77.4 | 109.2 | 159.4 | 165.0 | 207.9 | 219.3 | 233.1 | 247.2 |
| Hong Kong, China | 9.5 | 17.5 | 24.1 | 34.6 | 60.2 | 79.4 | 115.2 | 148.5 | 169.1 | 207.1 | 221.6 | 235.8 | 241.3 |
| Thailand | 8.8 | 12.4 | 19.2 | 25.4 | 37.3 | 48.6 | 79.4 | 120.0 | 122.7 | 157.4 | 165.6 | 173.8 | 178.2 |
| Malaysia | 6.6 | 9.2 | 12.4 | 17.5 | 26.4 | 33.9 | 47.2 | 74.2 | 93.8 | 118.2 | 125.1 | 133.0 | 139.2 |
| Singapore | 3.7 | 5.2 | 9.4 | 14.5 | 21.8 | 29.7 | 44.7 | 68.2 | 92.7 | 114.7 | 124.3 | 133.9 | 135.5 |
| Philippines | 16.6 | 21.4 | 26.8 | 35.4 | 47.6 | 44.6 | 56.2 | 62.6 | 75.9 | 94.5 | 99.6 | 106.6 | 110.7 |
| New Zealand | 19.1 | 24.3 | 26.7 | 32.7 | 31.8 | 37.2 | 38.3 | 44.6 | 50.9 | 61.3 | 62.3 | 64.2 | 63.2 |
| Vietnam | | | | | | 11.9 | 15.0 | 22.3 | 31.2 | 44.8 | 48.5 | 52.6 | 55.8 |
| **South Asia** | | | | | | | | | | | | | |
| India | 78.6 | 93.9 | 117.2 | 135.2 | 157.6 | 202.6 | 270.5 | 346.6 | 460.2 | 644.7 | 707.0 | 771.1 | 825.8 |
| Pakistan | 8.6 | 12.3 | 17.3 | 20.2 | 27.3 | 37.9 | 50.2 | 63.0 | 74.0 | 94.4 | 100.2 | 106.2 | 112.5 |
| Bangladesh | 12.8 | 16.0 | 18.9 | 16.7 | 20.4 | 24.5 | 29.5 | 36.5 | 47.1 | 61.4 | 65.4 | 69.6 | 74.0 |
| Sri Lanka | 2.7 | 3.2 | 4.2 | 5.0 | 6.5 | 8.3 | 9.8 | 12.8 | 16.3 | 19.8 | 21.4 | 22.8 | 24.2 |
| **Europe/Central Asia** | | | | | | | | | | | | | |
| Germany | | | 921.6 | 1,038.9 | 1,225.9 | 1,311.9 | 1,543.2 | 1,720.5 | 1,900.2 | 1,955.1 | 2,011.2 | 2,061.2 | 2,088.0 |
| United Kingdom | 548.9 | 640.3 | 726.1 | 805.7 | 879.0 | 970.4 | 1,141.0 | 1,238.5 | 1,450.9 | 1,638.2 | 1,686.1 | 1,737.1 | 1,749.2 |
| France | 348.7 | 461.5 | 599.5 | 727.7 | 861.1 | 929.8 | 1,091.8 | 1,156.3 | 1,328.0 | 1,442.3 | 1,473.6 | 1,505.6 | 1,511.6 |
| Italy | 292.1 | 376.4 | 508.9 | 594.6 | 739.1 | 803.5 | 937.6 | 998.7 | 1,097.3 | 1,145.7 | 1,166.8 | 1,183.8 | 1,171.9 |
| Spain | 113.2 | 170.7 | 231.1 | 299.4 | 330.0 | 353.6 | 440.6 | 474.9 | 580.7 | 681.9 | 708.2 | 735.3 | 744.1 |
| Netherlands | 98.4 | 128.5 | 166.4 | 196.5 | 223.9 | 237.6 | 282.0 | 315.8 | 385.1 | 409.0 | 421.3 | 436.0 | 445.1 |
| Russian Federation | | | | | | | 385.9 | 239.7 | 259.7 | 349.9 | 375.7 | 406.2 | 435.8 |

| | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Turkey | | | 75.4 | 99.9 | 112.3 | 142.4 | 187.1 | 219.1 | 267.2 | 333.8 | 356.9 | 373.3 | 387.3 |
| Sweden | 84.8 | 109.1 | 133.5 | 151.6 | 162.0 | 177.8 | 201.3 | 208.4 | 245.6 | 278.6 | 290.0 | 297.9 | 297.3 |
| Switzerland | 101.7 | 129.9 | 159.6 | 166.2 | 180.7 | 194.7 | 224.8 | 225.9 | 249.9 | 266.1 | 274.7 | 283.8 | 288.4 |
| Belgium | 68.3 | 87.1 | 110.3 | 131.5 | 153.7 | 161.1 | 187.5 | 203.0 | 231.9 | 250.9 | 258.1 | 265.3 | 268.2 |
| Poland | | | | | | | 118.1 | 131.6 | 171.3 | 199.6 | 212.0 | 226.2 | 237.0 |
| Austria | 52.7 | 65.3 | 84.5 | 102.5 | 120.4 | 129.6 | 150.7 | 167.7 | 193.8 | 208.3 | 215.2 | 222.4 | 226.4 |
| Norway | 38.3 | 48.0 | 57.7 | 73.1 | 91.2 | 107.5 | 117.0 | 140.5 | 168.3 | 187.8 | 192.5 | 199.6 | 203.6 |
| Denmark | 52.2 | 67.4 | 80.8 | 88.1 | 101.0 | 115.5 | 123.9 | 139.1 | 160.1 | 170.4 | 177.1 | 180.2 | 178.3 |
| Greece | 28.5 | 41.9 | 59.3 | 75.8 | 93.0 | 93.7 | 99.6 | 106.0 | 125.6 | 155.5 | 162.0 | 168.5 | 173.4 |
| Finland | 32.4 | 41.0 | 51.7 | 64.1 | 74.5 | 85.1 | 100.3 | 96.5 | 121.9 | 138.0 | 144.7 | 151.1 | 152.4 |
| Ireland | 14.3 | 17.2 | 21.6 | 27.4 | 34.3 | 38.9 | 48.9 | 61.3 | 96.4 | 126.0 | 133.2 | 141.2 | 137.9 |
| Portugal | 21.0 | 28.5 | 38.7 | 48.0 | 61.5 | 64.3 | 84.7 | 92.2 | 112.6 | 117.7 | 119.2 | 121.3 | 121.3 |
| Czech Republic | | | | | | | 55.3 | 52.7 | 56.7 | 68.1 | 72.8 | 77.1 | 79.6 |
| Hungary | 14.5 | 18.0 | 24.4 | 33.1 | 39.6 | 43.2 | 44.4 | 39.4 | 47.9 | 59.0 | 61.4 | 62.1 | 62.5 |
| Romania | | | | | 40.9 | 48.2 | 44.0 | 39.5 | 37.1 | 48.9 | 52.8 | 55.9 | 61.1 |
| Ukraine | | | | | | | 72.0 | 34.5 | 31.3 | 45.2 | 48.5 | 52.4 | 53.5 |
| Kazakhstan | | | | | | | 26.3 | 16.2 | 18.3 | 30.0 | 33.2 | 36.1 | 37.3 |
| Slovak Republic | | | | | | 18.2 | 19.5 | 16.8 | 20.3 | 25.8 | 28.0 | 30.9 | 32.9 |
| Croatia | | | | | | | 25.2 | 18.2 | 21.3 | 26.7 | 27.9 | 29.4 | 30.1 |
| Slovenia | | | | | | | 16.6 | 16.1 | 19.9 | 23.8 | 25.2 | 26.9 | 27.9 |
| Luxembourg | 4.3 | 5.0 | 5.9 | 6.8 | 7.6 | 8.6 | 12.4 | 15.1 | 20.3 | 24.3 | 25.8 | 27.0 | 26.7 |
| Belarus | | | | | | | 14.4 | 9.4 | 12.7 | 18.3 | 20.1 | 21.9 | 24.0 |
| Uzbekistan | | | | | | | 14.0 | 11.4 | 13.8 | 17.9 | 19.2 | 21.0 | 22.9 |
| Lithuania | | | | | | | 16.1 | 9.3 | 11.4 | 16.6 | 17.9 | 19.5 | 20.1 |
| **Middle East/North African countries** | | | | | | | | | | | | | |
| Saudi Arabia | | | 44.1 | 110.0 | 153.7 | 121.8 | 144.1 | 166.0 | 188.4 | 226.9 | 234.1 | 242.0 | 252.1 |
| Iran, Islamic Rep. | | 24.2 | 41.2 | 66.1 | 57.3 | 69.4 | 70.3 | 83.1 | 101.3 | 133.0 | 140.8 | 151.8 | 160.3 |
| Israel | 12.3 | 19.6 | 28.6 | 41.3 | 49.8 | 57.6 | 71.1 | 97.4 | 123.7 | 137.6 | 144.7 | 152.5 | 158.8 |
| Egypt, Arab Rep. | 12.0 | 17.3 | 20.3 | 24.1 | 38.5 | 53.3 | 65.6 | 77.5 | 99.8 | 118.8 | 126.9 | 135.9 | 145.5 |
| Algeria | 13.8 | 14.5 | 19.7 | 26.1 | 35.3 | 44.6 | 46.4 | 47.0 | 54.8 | 69.6 | 71.0 | 73.1 | 75.3 |
| Morocco | 7.5 | 9.0 | 12.1 | 15.4 | 20.1 | 23.6 | 29.3 | 30.7 | 37.0 | 47.2 | 50.9 | 52.2 | 55.3 |
| Libya | | | | | | | | | 34.5 | 40.4 | 42.5 | 45.4 | 48.6 |
| Tunisia | | 3.4 | 4.2 | 6.3 | 8.6 | 10.6 | 12.2 | 14.8 | 19.4 | 24.1 | 25.5 | 27.1 | 28.5 |
| Syrian Arab Republic | 2.2 | 3.1 | 3.7 | 6.9 | 9.5 | 10.9 | 11.8 | 17.3 | 19.3 | 23.8 | 25.0 | 26.0 | 27.4 |
| Lebanon | | | | | | | 8.4 | 14.9 | 16.8 | 20.5 | 20.4 | 21.9 | 23.7 |
| **Sub-Saharan Africa** | | | | | | | | | | | | | |
| South Africa | 38.4 | 53.3 | 68.6 | 82.0 | 95.5 | 102.1 | 110.9 | 115.8 | 132.9 | 160.6 | 169.2 | 177.8 | 183.2 |
| Nigeria | 12.8 | 16.0 | 19.8 | 25.9 | 31.5 | 27.0 | 35.0 | 39.5 | 46.0 | 61.9 | 65.7 | 70.0 | 73.7 |
| Angola | | | | | | 7.2 | 8.5 | 6.7 | 9.1 | 14.9 | 17.7 | 21.3 | 24.5 |
| Sudan | 3.3 | 3.6 | 3.9 | 4.9 | 5.5 | 5.7 | 7.1 | 9.1 | 12.4 | 16.6 | 18.4 | 20.3 | 22.0 |
| Kenya | 2.1 | 2.5 | 3.3 | 5.2 | 7.1 | 8.0 | 10.5 | 11.4 | 12.7 | 15.2 | 16.1 | 17.2 | 17.9 |
| Tanzania | | | | | | | 6.8 | 7.4 | 9.1 | 12.5 | 13.4 | 14.3 | 15.4 |
| Ethiopia | | | | | | 4.9 | 6.2 | 6.6 | 8.2 | 11.2 | 12.4 | 13.8 | 15.3 |
| Cameroon | 2.8 | 3.1 | 3.4 | 4.6 | 6.3 | 9.9 | 8.8 | 8.0 | 10.1 | 12.1 | 12.5 | 12.9 | 13.4 |
| Uganda | | | | | | 2.5 | 3.2 | 4.5 | 6.2 | 8.4 | 9.3 | 10.1 | 11.0 |
| Cote d'Ivoire | 2.0 | 2.9 | 4.6 | 6.3 | 7.7 | 7.8 | 8.3 | 8.9 | 10.4 | 10.4 | 10.5 | 10.7 | 10.9 |
| **South America/Caribbean countries** | | | | | | | | | | | | | |
| Brazil | 105.3 | 131.5 | 191.1 | 311.6 | 430.4 | 454.2 | 501.8 | 583.6 | 644.7 | 739.6 | 769.0 | 812.6 | 853.8 |
| Mexico | 94.4 | 133.7 | 181.0 | 245.2 | 345.6 | 380.4 | 413.3 | 445.8 | 581.4 | 636.8 | 667.4 | 688.8 | 701.0 |
| Argentina | 108.3 | 130.6 | 158.6 | 184.7 | 212.1 | 186.6 | 182.2 | 250.3 | 284.2 | 313.6 | 340.2 | 369.6 | 395.4 |
| Venezuela, RB | 41.1 | 55.4 | 67.3 | 77.8 | 87.8 | 83.8 | 95.3 | 112.9 | 117.1 | 132.9 | 146.6 | 159.0 | 166.6 |
| Colombia | 18.1 | 22.7 | 30.2 | 39.7 | 51.6 | 57.7 | 73.4 | 89.9 | 94.1 | 114.0 | 121.9 | 131.1 | 134.4 |
| Chile | 14.1 | 16.9 | 21.1 | 19.7 | 28.0 | 29.2 | 40.5 | 61.4 | 75.2 | 92.4 | 96.7 | 101.2 | 104.4 |
| Peru | 16.4 | 22.1 | 27.4 | 34.9 | 39.1 | 39.7 | 36.1 | 47.1 | 53.3 | 65.4 | 70.5 | 76.7 | 84.3 |
| Dominican Republic | 3.0 | 3.4 | 5.3 | 8.2 | 10.5 | 11.6 | 13.3 | 17.2 | 24.0 | 28.5 | 31.6 | 34.3 | 36.1 |
| Uruguay | 11.0 | 11.5 | 12.6 | 13.6 | 17.0 | 14.0 | 16.9 | 20.6 | 22.8 | 23.9 | 25.0 | 26.9 | 29.3 |
| **North America** | | | | | | | | | | | | | |
| United States | 2,545.8 | 3,189.8 | 3,721.7 | 4,276.9 | 5,128.0 | 6,011.0 | 7,055.0 | 7,972.8 | 9,764.8 | 10,950.6 | 11,265.2 | 11,490.5 | 11,616.9 |
| Canada | 167.9 | 222.0 | 276.9 | 343.3 | 412.0 | 471.7 | 543.6 | 592.1 | 724.9 | 821.9 | 844.6 | 867.4 | 870.9 |

## Document 3 | Amount of supply of primary energy, $CO_2$ emissions | By country, in order of amount of $CO_2$ emissions

Source: Key World Energy Statistics 2009, IEA | GDP: in U.S. dollars in 2000 | Numerical values are as of 2007

| | Population<br>1 million people | GDP<br>US$1 billion | Amount of supply of primary energy<br>1 million toe | $CO_2$ emissions<br>1 million $tCO_2$ | Amount of supply of primary energy per capita<br>toe/person | Amount of supply of primary energy per GDP<br>toe/US$1,000 | Amount of $CO_2$ emissions per capita<br>$tCO_2$/person | Amount of $CO_2$ emissions per GDP<br>$kgCO_2$/US$ |
|---|---|---|---|---|---|---|---|---|
| **East Asia/Pacific countries** | | | | | | | | |
| China | 1,320 | 2,388 | 1,956 | 6,028 | 1.48 | 0.82 | 4.57 | 2.52 |
| Japan | 128 | 5,205 | 514 | 1,236 | 4.02 | 0.10 | 9.68 | 0.24 |
| Republic of Korea | 48 | 706 | 222 | 489 | 4.59 | 0.31 | 10.09 | 0.69 |
| Australia | 21 | 508 | 124 | 396 | 5.87 | 0.24 | 18.75 | 0.78 |
| Indonesia | 226 | 233 | 191 | 377 | 0.84 | 0.82 | 1.67 | 1.62 |
| Taiwan | 23 | 416 | 110 | 276 | 4.81 | 0.26 | 12.08 | 0.66 |
| Thailand | 64 | 173 | 104 | 226 | 1.63 | 0.60 | 3.54 | 1.30 |
| Malaysia | 27 | 133 | 73 | 177 | 2.73 | 0.55 | 6.68 | 1.33 |
| Vietnam | 85 | 53 | 56 | 94 | 0.66 | 1.06 | 1.10 | 1.78 |
| Philippines | 88 | 107 | 40 | 72 | 0.45 | 0.37 | 0.82 | 0.67 |
| DPR of Korea | 24 | 11 | 18 | 62 | 0.77 | 1.61 | 2.62 | 5.48 |
| Other countries total | 82 | 467 | 84 | 158 | | | | |
| **South Asia** | | | | | | | | |
| India | 1,123 | 771 | 595 | 1,324 | 0.53 | 0.77 | 1.18 | 1.72 |
| Pakistan | 162 | 106 | 83 | 138 | 0.51 | 0.78 | 0.85 | 1.30 |
| Other countries total | 207 | 99 | 45 | 56 | | | | |
| **Europe/Central Asia** | | | | | | | | |
| Russian Federation | 142 | 406 | 672 | 1,587 | 4.75 | 1.65 | 11.21 | 3.91 |
| Germany | 82 | 2,065 | 331 | 798 | 4.03 | 0.16 | 9.71 | 0.39 |
| United Kingdom | 61 | 1,766 | 211 | 523 | 3.48 | 0.12 | 8.60 | 0.30 |
| Italy | 59 | 1,184 | 178 | 438 | 3.00 | 0.15 | 7.38 | 0.37 |
| France | 64 | 1,506 | 264 | 369 | 4.15 | 0.18 | 5.81 | 0.25 |
| Spain | 45 | 734 | 144 | 345 | 3.21 | 0.20 | 7.68 | 0.47 |
| Ukraine | 46 | 52 | 137 | 314 | 2.96 | 2.63 | 6.77 | 6.01 |
| Poland | 38 | 226 | 97 | 305 | 2.55 | 0.43 | 7.99 | 1.35 |
| Turkey | 74 | 372 | 100 | 265 | 1.35 | 0.27 | 3.59 | 0.71 |
| Kazakhstan | 15 | 36 | 66 | 190 | 4.29 | 1.84 | 12.30 | 5.27 |
| Netherlands | 16 | 440 | 80 | 182 | 4.91 | 0.18 | 11.13 | 0.41 |
| Czech Republic | 10 | 77 | 46 | 122 | 4.43 | 0.59 | 11.83 | 1.58 |
| Uzbekistan | 27 | 21 | 49 | 113 | 1.81 | 2.31 | 4.22 | 5.39 |
| Belgium | 11 | 266 | 57 | 106 | 5.37 | 0.21 | 9.97 | 0.40 |
| Greece | 11 | 170 | 32 | 98 | 2.88 | 0.19 | 8.74 | 0.58 |
| Romania | 22 | 56 | 39 | 92 | 1.81 | 0.70 | 4.27 | 1.64 |
| Austria | 8 | 221 | 33 | 70 | 3.99 | 0.15 | 8.38 | 0.31 |
| Finland | 5 | 151 | 36 | 64 | 6.90 | 0.24 | 12.19 | 0.43 |
| Belarus | 10 | 22 | 28 | 63 | 2.89 | 1.29 | 6.46 | 2.88 |
| Portugal | 11 | 122 | 25 | 55 | 2.36 | 0.21 | 5.20 | 0.45 |
| Hungary | 10 | 62 | 27 | 54 | 2.66 | 0.43 | 5.36 | 0.87 |
| Denmark | 5 | 179 | 20 | 50 | 3.60 | 0.11 | 9.24 | 0.28 |
| Bulgaria | 8 | 18 | 20 | 50 | 2.65 | 1.10 | 6.57 | 2.73 |
| Serbia | 7 | 13 | 16 | 50 | 2.14 | 1.20 | 6.73 | 3.78 |
| Other countries total | 92 | 1,156 | 241 | 439 | | | | |
| **Middle East/North African countries** | | | | | | | | |
| Iran (Islamic Republic of) | 71 | 152 | 185 | 466 | 2.60 | 1.22 | 6.56 | 3.07 |
| Saudi Arabia | 24 | 242 | 150 | 358 | 6.21 | 0.62 | 14.79 | 1.48 |
| Egypt | 75 | 136 | 67 | 169 | 0.89 | 0.49 | 2.24 | 1.24 |
| United Arab Emirates | 4 | 115 | 52 | 131 | 11.83 | 0.45 | 29.91 | 1.13 |
| Iraq | 28 | 21 | 33 | 91 | 1.20 | 1.59 | 3.33 | 4.38 |
| Algeria | 34 | 73 | 37 | 86 | 1.09 | 0.50 | 2.53 | 1.17 |
| Kuwait | 3 | 62 | 25 | 67 | 9.46 | 0.41 | 25.09 | 1.08 |
| Israel | 7 | 152 | 22 | 66 | 3.06 | 0.14 | 9.19 | 0.43 |
| Syrian Arab Republic | 20 | 27 | 20 | 54 | 0.99 | 0.74 | 2.70 | 2.02 |
| Other countries total | 84 | 254 | 107 | 264 | | | | |

| | Population<br>1 million people | GDP<br>US$1 billion | Amount of supply of primary energy<br>1 million toe | $CO_2$ emissions<br>1 million $tCO_2$ | Amount of supply of primary energy per capita<br>toe/person | Amount of supply of primary energy per GDP<br>toe/US$1,000 | Amount of $CO_2$ emissions per capita<br>$tCO_2$/person | Amount of $CO_2$ emissions per GDP<br>$kgCO_2$/US$ |
|---|---|---|---|---|---|---|---|---|
| **Sub-Saharan Africa** | | | | | | | | |
| South Africa | 48 | 178 | 134 | 346 | 2.82 | 0.75 | 7.27 | 1.94 |
| Nigeria | 148 | 70 | 107 | 51 | 0.72 | 1.53 | 0.35 | 0.74 |
| Other countries total | 425 | 176 | 171 | 100 | | | | |
| **South America/Caribbean countries** | | | | | | | | |
| Mexico | 106 | 755 | 184 | 438 | 1.74 | 0.24 | 4.14 | 0.58 |
| Brazil | 192 | 809 | 236 | 347 | 1.23 | 0.29 | 1.81 | 0.43 |
| Argentina | 40 | 370 | 73 | 163 | 1.85 | 0.20 | 4.12 | 0.44 |
| Venezuela | 27 | 159 | 64 | 144 | 2.32 | 0.40 | 5.24 | 0.90 |
| Chile | 17 | 101 | 31 | 71 | 1.86 | 0.30 | 4.28 | 0.70 |
| Colombia | 46 | 131 | 29 | 56 | 0.63 | 0.22 | 1.21 | 0.43 |
| Other countries total | 136 | 338 | 111 | 217 | | | | |
| **North America** | | | | | | | | |
| United States of America | 302 | 11,468 | 2,340 | 5,769 | 7.75 | 0.20 | 19.10 | 0.50 |
| Canada | 33 | 869 | 269 | 573 | 8.17 | 0.31 | 17.37 | 0.66 |

## Document 4 | Changes in amount of cereal production | By country, top 25 countries

Source: FAOSTAT, FAO

Unit: 10,000 tons

| | 1961 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **World total** | 87,702 | 99,876 | 119,263 | 135,996 | 155,018 | 182,124 | 195,209 | 189,770 | 206,039 | 226,860 | 252,511 |
| China | 10,966 | 16,216 | 20,084 | 24,453 | 28,029 | 33,988 | 40,441 | 41,866 | 40,734 | 42,937 | 48,101 |
| United States of America | 16,380 | 18,379 | 18,698 | 24,953 | 27,013 | 34,712 | 31,240 | 27,760 | 34,281 | 36,654 | 40,377 |
| India | 8,738 | 7,970 | 11,391 | 12,781 | 14,049 | 16,568 | 19,392 | 21,001 | 23,493 | 24,000 | 26,658 |
| Russian Federation | | | | | | | | 6,190 | 6,433 | 7,656 | 10,639 |
| Brazil | 1,504 | 2,035 | 2,370 | 2,624 | 3,322 | 3,601 | 3,249 | 4,964 | 4,590 | 5,567 | 7,968 |
| Indonesia | 1,437 | 1,534 | 2,216 | 2,524 | 3,364 | 4,336 | 5,191 | 5,799 | 6,158 | 6,667 | 7,657 |
| France | 2,080 | 2,913 | 3,144 | 3,573 | 4,802 | 5,568 | 5,511 | 5,355 | 6,570 | 6,410 | 7,009 |
| Canada | 1,673 | 3,223 | 2,856 | 3,711 | 4,136 | 4,824 | 5,681 | 4,934 | 5,109 | 5,096 | 5,603 |
| Ukraine | | | | | | | | 3,236 | 2,381 | 3,726 | 5,271 |
| Germany | 1,726 | 2,062 | 2,375 | 3,016 | 3,271 | 3,756 | 3,758 | 3,986 | 4,527 | 4,598 | 5,010 |
| Bangladesh | 1,452 | 1,585 | 1,691 | 1,932 | 2,170 | 2,413 | 2,775 | 2,770 | 3,950 | 4,115 | 4,910 |
| Vietnam | 929 | 969 | 1,043 | 1,057 | 1,208 | 1,646 | 1,990 | 2,614 | 3,454 | 3,962 | 4,326 |
| Argentina | 1,451 | 1,384 | 1,992 | 2,304 | 1,865 | 2,807 | 2,012 | 2,431 | 3,875 | 3,816 | 3,668 |
| Mexico | 852 | 1,249 | 1,501 | 1,663 | 2,089 | 2,740 | 2,556 | 2,688 | 2,799 | 2,906 | 3,614 |
| Pakistan | 673 | 787 | 1,210 | 1,313 | 1,707 | 1,770 | 2,096 | 2,504 | 3,046 | 3,351 | 3,597 |
| Thailand | 1,077 | 1,226 | 1,586 | 1,840 | 2,061 | 2,561 | 2,117 | 2,641 | 3,052 | 3,451 | 3,442 |
| Australia | 915 | 968 | 1,290 | 1,777 | 1,640 | 2,494 | 2,305 | 2,739 | 3,445 | 3,984 | 3,353 |
| Myanmar | 694 | 823 | 831 | 939 | 1,368 | 1,507 | 1,442 | 1,848 | 2,197 | 2,898 | 3,195 |
| Nigeria | 789 | 841 | 898 | 835 | 779 | 1,189 | 1,768 | 2,251 | 2,137 | 2,603 | 3,021 |
| Turkey | 1,273 | 1,476 | 1,599 | 2,221 | 2,442 | 2,649 | 3,020 | 2,813 | 3,225 | 3,635 | 2,928 |
| Poland | 1,612 | 1,616 | 1,626 | 1,956 | 1,834 | 2,374 | 2,801 | 2,591 | 2,234 | 2,693 | 2,766 |
| United Kingdom | 972 | 1,372 | 1,327 | 1,394 | 1,947 | 2,249 | 2,257 | 2,187 | 2,399 | 2,100 | 2,428 |
| Spain | 750 | 887 | 1,026 | 1,421 | 1,867 | 2,097 | 1,876 | 1,157 | 2,456 | 1,423 | 2,389 |
| Philippines | 518 | 545 | 760 | 884 | 1,078 | 1,273 | 1,474 | 1,470 | 1,690 | 1,986 | 2,374 |
| Egypt | 501 | 614 | 748 | 813 | 810 | 856 | 1,302 | 1,610 | 2,011 | 2,241 | 2,281 |

| Countries | Income level | Region |
|---|---|---|
| Austria | High-income countries (OECD) | Europe/Central Asia |
| Belgium | High-income countries (OECD) | Europe/Central Asia |
| Czech Republic | High-income countries (OECD) | Europe/Central Asia |
| Denmark | High-income countries (OECD) | Europe/Central Asia |
| Finland | High-income countries (OECD) | Europe/Central Asia |
| France | High-income countries (OECD) | Europe/Central Asia |
| Germany | High-income countries (OECD) | Europe/Central Asia |
| Greece | High-income countries (OECD) | Europe/Central Asia |
| Hungary | High-income countries (OECD) | Europe/Central Asia |
| Italy | High-income countries (OECD) | Europe/Central Asia |
| Ireland | High-income countries (OECD) | Europe/Central Asia |
| Luxemberg | High-income countries (OECD) | Europe/Central Asia |
| Netherlands | High-income countries (OECD) | Europe/Central Asia |
| Norway | High-income countries (OECD) | Europe/Central Asia |
| Portugal | High-income countries (OECD) | Europe/Central Asia |
| Slovakia | High-income countries (OECD) | Europe/Central Asia |
| Spain | High-income countries (OECD) | Europe/Central Asia |
| Sweden | High-income countries (OECD) | Europe/Central Asia |
| Switzerland | High-income countries (OECD) | Europe/Central Asia |
| United Kingdom | High-income countries (OECD) | Europe/Central Asia |
| Australia | High-income countries (OECD) | East Asia/Pacific countries |
| Japan | High-income countries (OECD) | East Asia/Pacific countries |
| New Zealand | High-income countries (OECD) | East Asia/Pacific countries |
| Canada | High-income countries (OECD) | North America |
| United States of America | High-income countries (OECD) | North America |
| Croatia | High-income countries (non-OECD) | Europe/Central Asia |
| Cyprus | High-income countries (non-OECD) | Europe/Central Asia |
| Estonia | High-income countries (non-OECD) | Europe/Central Asia |
| Slovenia | High-income countries (non-OECD) | Europe/Central Asia |
| Bahrain | High-income countries (non-OECD) | Middle East/North African countries |
| Israel | High-income countries (non-OECD) | Middle East/North African countries |
| Kuwait | High-income countries (non-OECD) | Middle East/North African countries |
| Malta | High-income countries (non-OECD) | Middle East/North African countries |
| Oman | High-income countries (non-OECD) | Middle East/North African countries |
| Qatar | High-income countries (non-OECD) | Middle East/North African countries |
| Saudi Arabia | High-income countries (non-OECD) | Middle East/North African countries |
| United Arab Emirates | High-income countries (non-OECD) | Middle East/North African countries |
| Brunei Darussalam | High-income countries (non-OECD) | East Asia/Pacific countries |
| French Polynesia | High-income countries (non-OECD) | East Asia/Pacific countries |
| Guam | High-income countries (non-OECD) | East Asia/Pacific countries |
| New Caledonia | High-income countries (non-OECD) | East Asia/Pacific countries |
| Northern Mariana Islands | High-income countries (non-OECD) | East Asia/Pacific countries |
| Antigua and Barbuda | High-income countries (non-OECD) | South America/Caribbean countries |
| Bahamas | High-income countries (non-OECD) | South America/Caribbean countries |
| Barbados | High-income countries (non-OECD) | South America/Caribbean countries |
| Puerto Rico | High-income countries (non-OECD) | South America/Caribbean countries |
| Trinidad and Tobago | High-income countries (non-OECD) | South America/Caribbean countries |
| Botswana | High-level middle-income countries | Sub-Saharan Africa |
| Gabon | High-level middle-income countries | Sub-Saharan Africa |
| Mauritius | High-level middle-income countries | Sub-Saharan Africa |
| Namibia | High-level middle-income countries | Sub-Saharan Africa |
| Seychelles | High-level middle-income countries | Sub-Saharan Africa |
| South Africa | High-level middle-income countries | Sub-Saharan Africa |
| Belarus | High-level middle-income countries | Europe/Central Asia |
| Bosnia and Herzegovina | High-level middle-income countries | Europe/Central Asia |
| Bulgaria | High-level middle-income countries | Europe/Central Asia |
| Kazakhstan | High-level middle-income countries | Europe/Central Asia |
| Latvia | High-level middle-income countries | Europe/Central Asia |
| Lithuania | High-level middle-income countries | Europe/Central Asia |
| Montenegro | High-level middle-income countries | Europe/Central Asia |
| Poland | High-level middle-income countries | Europe/Central Asia |
| Romania | High-level middle-income countries | Europe/Central Asia |
| Russian Federation | High-level middle-income countries | Europe/Central Asia |
| Serbia | High-level middle-income countries | Europe/Central Asia |
| The former Yugoslavia Republic of Macedonia | High-level middle-income countries | Europe/Central Asia |
| Turkey | High-level middle-income countries | Europe/Central Asia |
| Algeria | High-level middle-income countries | Middle East/North African countries |
| Lebanon | High-level middle-income countries | Middle East/North African countries |
| Libyan Arab Jamahiriya | High-level middle-income countries | Middle East/North African countries |
| Fiji | High-level middle-income countries | East Asia/Pacific countries |
| Malaysia | High-level middle-income countries | East Asia/Pacific countries |
| Argentina | High-level middle-income countries | South America/Caribbean countries |
| Brazil | High-level middle-income countries | South America/Caribbean countries |

| Countries | Income level | Region |
|---|---|---|
| Chile | High-level middle-income countries | South America/Caribbean countries |
| Colombia | High-level middle-income countries | South America/Caribbean countries |
| Costa Rica | High-level middle-income countries | South America/Caribbean countries |
| Cuba | High-level middle-income countries | South America/Caribbean countries |
| Dominican Republic | High-level middle-income countries | South America/Caribbean countries |
| Grenada | High-level middle-income countries | South America/Caribbean countries |
| Jamaica | High-level middle-income countries | South America/Caribbean countries |
| Mexico | High-level middle-income countries | South America/Caribbean countries |
| Panama | High-level middle-income countries | South America/Caribbean countries |
| Peru | High-level middle-income countries | South America/Caribbean countries |
| Saint Kitts and Nevis | High-level middle-income countries | South America/Caribbean countries |
| Saint Lucia | High-level middle-income countries | South America/Caribbean countries |
| Suriname | High-level middle-income countries | South America/Caribbean countries |
| Uruguay | High-level middle-income countries | South America/Caribbean countries |
| Angola | Low-level middle-income countries | Sub-Saharan Africa |
| Cameroon | Low-level middle-income countries | Sub-Saharan Africa |
| Cape Verde | Low-level middle-income countries | Sub-Saharan Africa |
| Congo | Low-level middle-income countries | Sub-Saharan Africa |
| Lesotho | Low-level middle-income countries | Sub-Saharan Africa |
| Nigeria | Low-level middle-income countries | Sub-Saharan Africa |
| Sao Tome and Principe | Low-level middle-income countries | Sub-Saharan Africa |
| Sudan | Low-level middle-income countries | Sub-Saharan Africa |
| Swaziland | Low-level middle-income countries | Sub-Saharan Africa |
| Albania | Low-level middle-income countries | Europe/Central Asia |
| Armenia | Low-level middle-income countries | Europe/Central Asia |
| Azerbaijan | Low-level middle-income countries | Europe/Central Asia |
| Georgia | Low-level middle-income countries | Europe/Central Asia |
| Turkmenistan | Low-level middle-income countries | Europe/Central Asia |
| Ukraine | Low-level middle-income countries | Europe/Central Asia |
| Djibouti | Low-level middle-income countries | Middle East/North African countries |
| Egypt | Low-level middle-income countries | Middle East/North African countries |
| Iraq | Low-level middle-income countries | Middle East/North African countries |
| Jordan | Low-level middle-income countries | Middle East/North African countries |
| Morocco | Low-level middle-income countries | Middle East/North African countries |
| Syrian Arab Republic | Low-level middle-income countries | Middle East/North African countries |
| Tunisia | Low-level middle-income countries | Middle East/North African countries |
| China | Low-level middle-income countries | East Asia/Pacific countries |
| Indonesia | Low-level middle-income countries | East Asia/Pacific countries |



| Countries | Income level | Region |
|---|---|---|
| Mongolia | Low-level middle-income countries | East Asia/Pacific countries |
| Philippines | Low-level middle-income countries | East Asia/Pacific countries |
| Solomon Islands | Low-level middle-income countries | East Asia/Pacific countries |
| Thailand | Low-level middle-income countries | East Asia/Pacific countries |
| Timoe-Leste | Low-level middle-income countries | East Asia/Pacific countries |
| Vanyatu | Low-level middle-income countries | East Asia/Pacific countries |
| Bhutan | Low-level middle-income countries | South Asia |
| India | Low-level middle-income countries | South Asia |
| Pakistan | Low-level middle-income countries | South Asia |
| Sri Lanka | Low-level middle-income countries | South Asia |
| Belize | Low-level middle-income countries | South America/Caribbean countries |
| Ecuador | Low-level middle-income countries | South America/Caribbean countries |
| El Salvador | Low-level middle-income countries | South America/Caribbean countries |
| Guatemala | Low-level middle-income countries | South America/Caribbean countries |
| Guyana | Low-level middle-income countries | South America/Caribbean countries |
| Honduras | Low-level middle-income countries | South America/Caribbean countries |
| Nicaragua | Low-level middle-income countries | South America/Caribbean countries |
| Paraguay | Low-level middle-income countries | South America/Caribbean countries |
| Benin | Low-income countries | Sub-Saharan Africa |
| Burkina Faso | Low-income countries | Sub-Saharan Africa |
| Burundi | Low-income countries | Sub-Saharan Africa |
| Central African Republic | Low-income countries | Sub-Saharan Africa |
| Chad | Low-income countries | Sub-Saharan Africa |
| Eritrea | Low-income countries | Sub-Saharan Africa |
| Ethiopia | Low-income countries | Sub-Saharan Africa |
| Gambia | Low-income countries | Sub-Saharan Africa |
| Ghana | Low-income countries | Sub-Saharan Africa |
| Guinea | Low-income countries | Sub-Saharan Africa |
| Guinea-Bissau | Low-income countries | Sub-Saharan Africa |
| Kenya | Low-income countries | Sub-Saharan Africa |
| Liberia | Low-income countries | Sub-Saharan Africa |
| Madagascar | Low-income countries | Sub-Saharan Africa |
| Malawi | Low-income countries | Sub-Saharan Africa |
| Mali | Low-income countries | Sub-Saharan Africa |
| Mauritania | Low-income countries | Sub-Saharan Africa |
| Mozambique | Low-income countries | Sub-Saharan Africa |
| Niger | Low-income countries | Sub-Saharan Africa |
| Rwanda | Low-income countries | Sub-Saharan Africa |

| Countries | Income level | Region |
|---|---|---|
| Senegal | Low-income countries | Sub-Saharan Africa |
| Sierra Leone | Low-income countries | Sub-Saharan Africa |
| Somalia | Low-income countries | Sub-Saharan Africa |
| Togo | Low-income countries | Sub-Saharan Africa |
| Uganda | Low-income countries | Sub-Saharan Africa |
| Zambia | Low-income countries | Sub-Saharan Africa |
| Zimbabwe | Low-income countries | Sub-Saharan Africa |
| Kyrgyzstan | Low-income countries | Europe/Central Asia |
| Tajikistan | Low-income countries | Europe/Central Asia |
| Uzbekistan | Low-income countries | Europe/Central Asia |
| Yemen | Low-income countries | Middle East/North African countries |
| Cambodia | Low-income countries | East Asia/Pacific countries |
| Lao People's Democratic Republic | Low-income countries | East Asia/Pacific countries |
| Myanmar | Low-income countries | East Asia/Pacific countries |
| Vietnam | Low-income countries | East Asia/Pacific countries |
| Afghanistan | Low-income countries | South Asia |
| Bangladesh | Low-income countries | South Asia |
| Nepal | Low-income countries | South Asia |
| Haiti | Low-income countries | South America/Caribbean countries |

The Asahi Glass Foundation was established in 1933 as the Asahi Foundation for Chemical Industry Promotion in commemoration of the twenty-fifth anniversary (1932) of the founding of Asahi Glass Co., Ltd. Over most of its first half-century, with the exception of the chaotic postwar days, the foundation focused primarily on fostering research in the field of applied chemistry. To meet the demands of the new era, the foundation undertook the overall redesign of its programs in 1990, expanding the scope of its activities and establishing its commendation program. At the same time, it was renamed the Asahi Glass Foundation. The foundation has since sustained a variety of activities under its grant-making programs on technologies for the next generations and commendation programs with an international prize for environmental activities, namely the Blue Planet Prize. In addition to our numerous commitments to solving global environmental problems, our activities contribute to the creation of a society and civilization where all of humankind can be blessed with genuine wealth.

**Deciphering "Conditions for Survival" | Data Book |**

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