FY2009 Annual Report on the Environment／Annual Report on the Sound Material-Cycle Society／Annual Report on the Biodiversity
Our Responsibility and Commitment to Preserve the Earth －Challenge 25－

Introductory Chapter
The Course of the Earth
－Where Is the World Headed and Where Does Japan Find Itself?－

If we liken the history of the earth to one year, human history spans just about four hours. The history of mankind since the Industrial Revolution in the 18th century is equivalent to only about one second. In the rich and exquisite ecosystem that life born on the earth has built up over ages, humans have achieved amazing development by making use of a variety of resources. As a consequence of that development, however, human activities have grown to assume such proportions as to exponentially consume natural blessings and alter the global environment in that "last second." Where is the earth we live on heading?

In this Introductory Chapter, we go over the history of the earth and the history of mankind and give an overview of global trends, based on macro data, of changes in the world population, conditions of resources and economic activities in recent years, and also examine the situation in Japan. Further, we consider the impact on the global environment through an analysis of such trends.

1 Mankind Born on the Earth

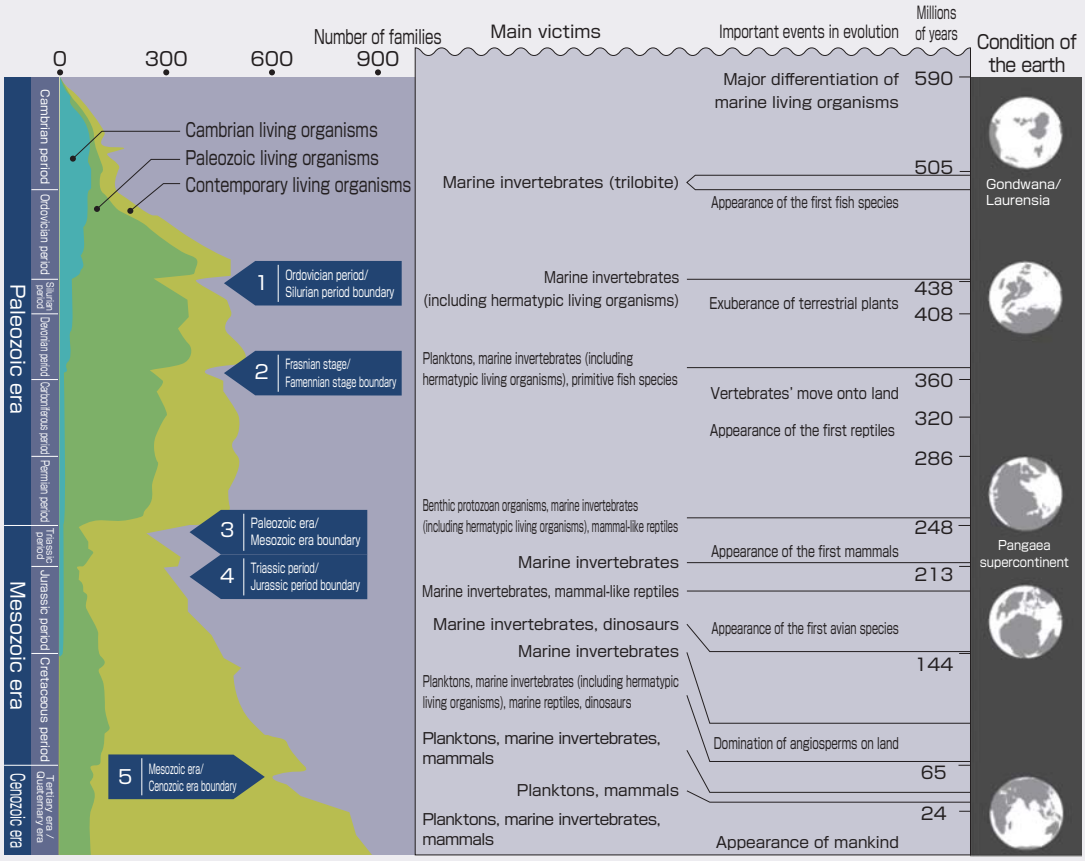
Life is thought to have come into existence on this earth some 4 billion years ago. And then, unicellular bacteria are believed to have spread all over the earth, and in particular, cyanobacteria are known to synthesize organic matter from water and carbon dioxide through photosynthesis and at the same time produce oxygen. In the Cambrian period (from 600 million years ago), the major phyla of multicellular animals that now exist are said to have come out en masse. Oxygen generated by underwater activities of photosynthetic organism built up in the atmosphere and the subsequent formation of the ozone layer blocked off ultraviolet rays and appears to have made it possible for living organisms to come ashore some 500 million years ago. Until then, land is believed to have been literally barren. Subsequently, fish species are said to have prospered in the Devonian period of the Paleozoic era (from some 410 million years ago) and then amphibian species in the Carboniferous period (from some 360 million years ago). During the mid-Triassic period, when the reptiles are believed to have extended their habitat to underwater and into the air, mammals came into existence, and ancestors of primates are believed to have been born about 85 million years ago. Some 65 million years ago, the extinction of dinosaurs and other giant reptiles created the opening in living space and then mammals are believed to have expanded their habitat explosively.

Regarding the evolution from apes to humans, the molecular evolutionary theory assumes that the phyletic line of gibbons became differentiated from the phyletic line that led to humans 18 million to 12 million years ago, and the phyletic line of orangutans differentiated 12 million years ago. Further, the phyletic line of gorillas differentiated eight million to four million years ago, and then the phyletic line of chimpanzees, which differ only 1-2% from humans in terms of DNA base sequence, is said to have diverged five million to four million years ago. The Homo genus is believed to have differentiated from the Australopithecine genus in Africa about two million years ago, and Homo sapiens, the modern humankind, is said to have appeared 400,000 to 250,000 years ago.

Many organism species have adapted themselves to changes in the environment by transforming their body shapes over many generations. However, the subsequent alteration of the environment by humans has been taking place much faster than the speed necessary for such adaptation. Humankind is also one of organism species, human beings are no different from other living organisms in that they cannot adapt themselves to the environment they are rapidly altering by transforming their body shapes.

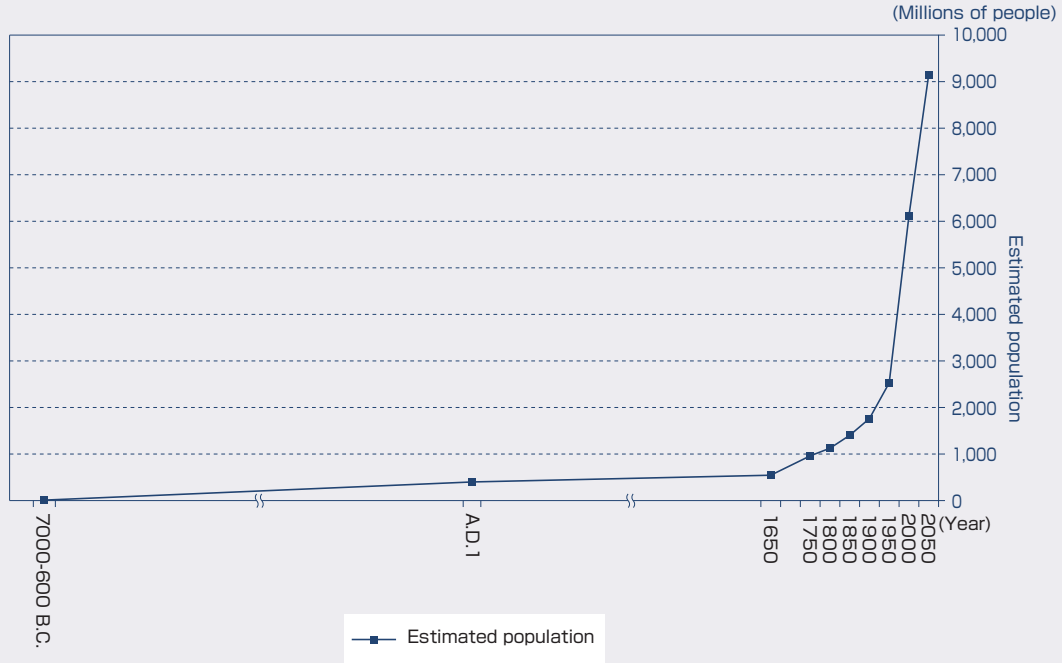
Human beings are believed to have improved their living conditions in the course of evolution. For example, it is thought that the use of simple pebble tools increased the amount of quarries, and the economy of efforts to catch preys made their living easier. And archanthropines, using their advanced techniques to make stone implements, succeeded in attaching blades to pebble tools and making a fire. From the time of archaic humans to that of new humans, tools became diversified and techniques were refined, and rich mental activity is also believed to have developed. Primitive agriculture and livestock husbandry, which are thought to have started in the New Stone Age, made further advances in ancient times, and the invention of metalware has changed the

Figure Int.-1-1 Five Major Mass Extinctions in Phanerozoic Time



Source: Prepared by the Ministry of the Environment based on Quarterly journal Biohistory, "Mass Extinction – Accelerator of Evolutions (Yukio Isozaki)" & Stanley, Steven M. "Extinction"

Figure Int.-1-2 Trends and Estimates of the World Population: B.C. - 2050



Source: Prepared by the Ministry of the Environment based on the National Institute of Population and Social Security Research, "Population Statistics of Japan (2010)"

lifestyles of humans considerably. This is how humans have achieved their present affluent way of life. Since the Industrial Revolution in particular, the per-capita environmental load increased, and the synergetic effect with the explosive growth of human population further augments burdens on the environment. Human activities expanded dramatically, altering the environment and considerably increasing the environmental load.

2 An Overview of Global Trends

(1) Population and urbanization: population increases and the concentration on cities

Human production and consumption activities are burdening the environment through extraction of resources and discharges of greenhouse gases and waste. Generally, it is thought that production and consumption activities increase in tandem with an increase in population and their impact on the environment increase accordingly. Thus, a survey of population trends in each region provides clues to estimate which regions are going to see greater impacts on the environment going forward.

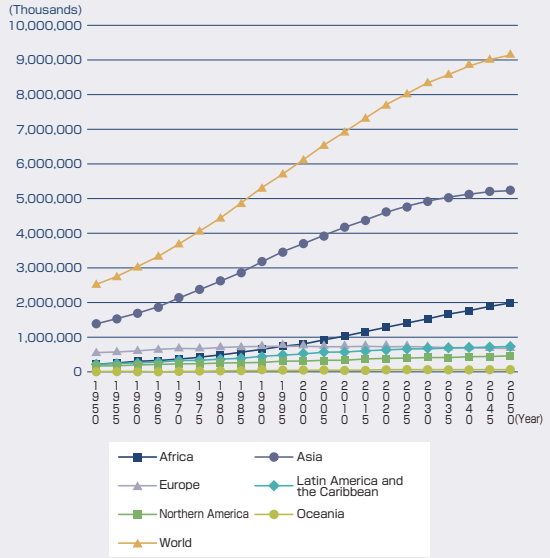
According to State of World Population 2009 released by the United Nations Population Fund, the world population stood at some 6.8 billion in 2009. The World Population Prospects 2008 indicates that the world population is expected to reach 7.0 billion in 2011 and top 9.0 billion in 2050 (Figure Int.-2-1). The regional breakdown of the world population shows that Asia accounts for a larger percentage of the population than other regions, with South-Central Asia that includes India and Eastern Asia inclusive of China account for particularly large percentages (Figure Int.-2-2).

The population trends of the two regions mentioned above show major differences in population growth rates. While the population of South-Central Asia is likely to continue to grow substantially in years to come, the population in Eastern Asia is forecast to start declining from around 2030 (Figure Int.-2-2). This raises concerns about increased burdens on the environment in Asia at large, and such concerns are likely to persist longer particularly in South-Central Asia.

Looking at regions other than Asia, it is clear that Africa has the distinctly high growth rate of population (Figure Int.-2-3). Africa has a large increase of a little over 1.6% in the average annual population growth rate between 2010 and 2050. On the other hand, the population growth rate in Europe is set to see a decline of about 0.15%.

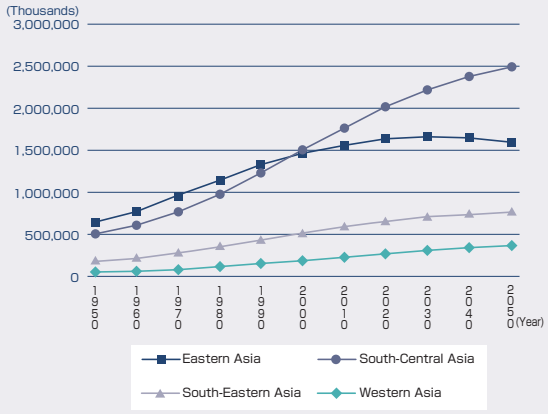
Meanwhile, Japan's total population is forecast to stay on the consistent downtrend going forward. The Japanese population is likely to accelerate its pace of decline year after year from the 2005 peak of some 127.77 million, with the total population breaking below the 100 million mark by 2050 (Figure Int.-2-4). In terms of an increase or decrease in population, the expected decline in Japan's total population is likely, in a sense, to have the effect of mitigating the environmental load. However, the impact of population trends on the environment needs to be captured from various aspects, including production and consumption patterns, industrial structures, and changes in life patterns and standards of living stemming from the ongoing fall in birthrate and the aging population.

Figure Int.-2-1 Population Trends in the World and Regions



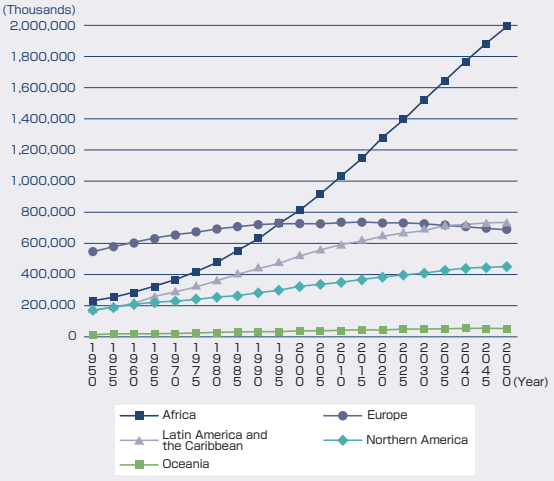
Source: Prepared by the Ministry of the Environment based on U.N. Population Division, "World Population Prospects: The 2008 Revision"

Figure Int.-2-2 Population Trends in Asia



Source: Prepared by the Ministry of the Environment based on U.N. Population Division, "World Population Prospects: The 2008 Revision"

Figure Int.-2-3 Population Trends in Non-Asia Regions



Source: Prepared by the Ministry of the Environment based on U.N. Population Division, "World Population Prospects: The 2008 Revision"

While the world population has been on a constant increase in recent years, led by population growth in Asia and Africa, areas of residence have been rapidly urbanized. A report by the United Nations Population Fund shows that in 2009, 3.4 billion people, or about half of the world's population, are living in urban areas. The urbanization trend is likely to continue going forward, with about 5.0 billion people expected to live in urban areas by 2030 and about 6.4 billion people, or about 70% of the world population, by 2050 (Figure Int.-2-5). This trend of urbanization is particularly noticeable in developing regions such as Asia and Africa (Figure Int.-2-6).

The rapid urbanization in developing regions tends to adversely affect the environment.

On the consumption front, in tandem with urbanization-triggered changes in lifestyles, massive amounts of wastes and domestic effluents are generated in association with mass consumption, heightening the so-called domestic environmental load. In developing regions, on the other hand, the introduction of decontamination technologies is generally insufficient in secondary industries responsible for mass production that supports rapid economic development, raising concern that effluents and wastes generated in production activities are not being treated adequately.

In economic and industrial aspects, economic development accelerates the shift to tertiary industries, raises the economic dependence on overseas as well as on informal sectors, and increases demand for labor in urban areas. The attendant rapid population influx into cities leads to excessive urbanization, and administrative measures to deal with unemployment and residential areas turning into slums are likely to squeeze public coffers, causing chronic delays in infrastructure development.

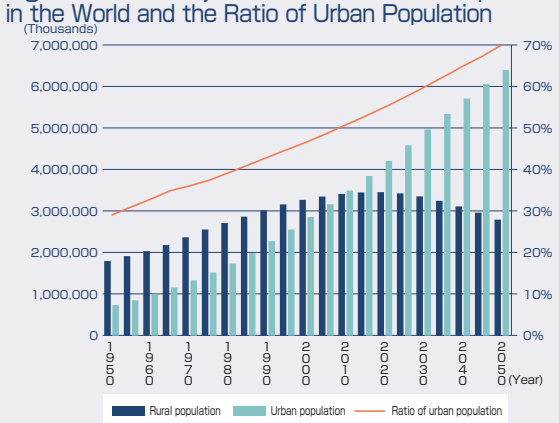
Furthermore, urbanization, accompanied by motorization, in developing countries and suburbanization that comes with it would increase the environmental load from traffic congestion and carbon dioxide emissions, exacerbated by the lack of adequate infrastructures.

In Japan, the status of urbanization is somewhat different from global trends. While Japan's urban population is expected to remain stable at around 85 million in 2010 onward, the rural population is forecast to trend sharply lower (Figure Int.-2-7). This indicates the decline in the population is going to affect rural areas more than urban areas. In rural areas, therefore, problems with environmental conservation due to the shortage of people who conserve and manage satochi-satoyama (community-based forest areas and the surrounding countryside) and problems of "marginal settlements" stemming from the aging population are feared to grow more serious.

Figure Int.-2-4 Trends of Japan's Total Population and Population Growth Rate

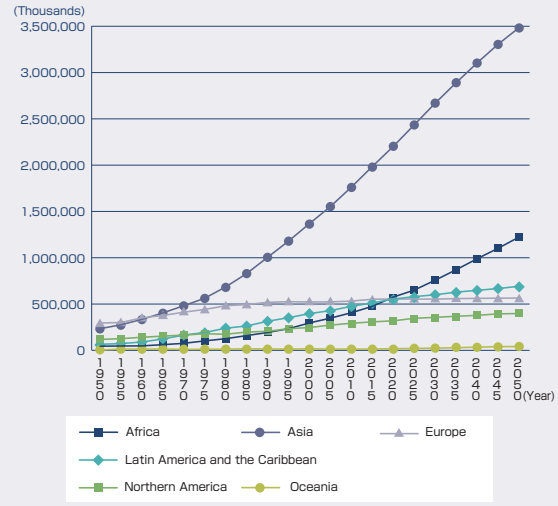
Source: Prepared by the Ministry of the Environment based on Statistics Bureau, Ministry of Internal Affairs and Communications, "National Population Census" & National Institute of Population and Social Security Research, "Estimation of Future Population"

Figure Int.-2-5 Projected Urban and Rural Populations in the World and the Ratio of Urban Population



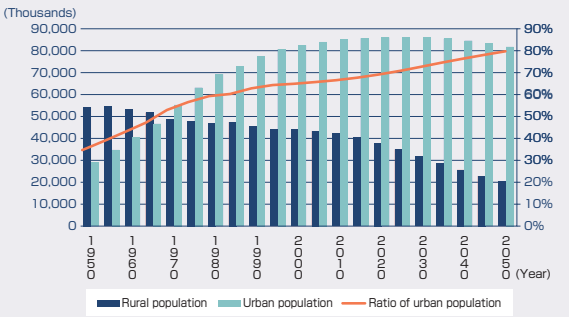
Source: Prepared by the Ministry of the Environment based on U.N. Population Division, "World Urbanization Prospects: The 2007 Revision Population Database"

Figure Int.-2-6 Trends of Urban Population by Region (1950-2050)



Source: Prepared by the Ministry of the Environment based on U.N. Population Division, "World Urbanization Prospects: The 2007 Revision Population Database"

Figure Int.-2-7 Projected Urban and Rural Populations in Japan and the Ratio of Urban Population



Source: Prepared by the Ministry of the Environment based on U.N. Population Division, "World Urbanization Prospects: The 2007 Revision Population Database"

(2) Water: unevenly distributed water resources

Water is essential for human existence. A report by the World Wildlife Fund (WWF) shows that about 70% of water utilized around the world is used for agriculture, 20% in industry and 10% at households (Figure Int.-2-8). While the world's water utilization volume almost doubled between 1960 and 2000, the world population also doubled during the same period, indicating that per-capita water utilization volume has been almost flat. Thus, water utilization volume in the world is expected to increase going forward in association with an increase in the world population.

Utilization of volume of water resources is likely to increase globally as seen above. Water resources are unevenly distributed around the globe and running short. Annual per-capita water resources in the world indicate that while Canada, Norway and New Zealand are bestowed with abundant water resources, countries in the Middle East are in short supply of water resources (Figure Int.-2-9).

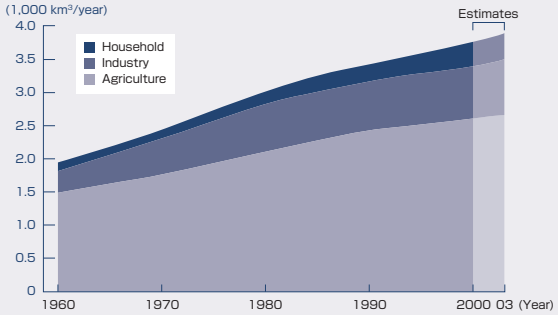
The uneven distribution of water resources becomes even more evident if we look at the relationship between per-capita water resources and the population. A person is said to require some 4,000 m^3 of water per year, but about 4.5 billion people live in countries with water resources far less than this required amount. People are in the "water stress" state when the per-capita maximum available amount of water resources falls short of 1,700 m^3, and in the "water scarcity" state when that amount is less than 1,000 m^3. In 2008, people in these states of water availability numbered some 2.0 billion and 330 million, respectively (Figure Int.-2-10).

Japan's annual per-capita water resources stand at some 3,400 m^3, and the country is not in the state of "water stress" as described above. In recent years, however, there have been wide gaps in the annual amount of rainfall between years of scarce rain and years of heavy rain. Available water resources in years of scarce rain, which come around once every 10 years, tended to decrease, lowering the degree of water utilization security in Japan.

A U.N. report released by UNESCO estimates that populations living in seriously water-stressed areas will reach 3.9 billion by 2030, an increase of 1.0 billion over 2005. Going forward, water utilization in Asia is forecast to increase dramatically, estimated to rise by some one trillion m^3 from 2.16 trillion m^3 in 1995 to reach 3.10 trillion m^3 by 2025. This is equivalent to about 1.4 times the amount of water utilization in North America in 1995 (Figure 4-1-9).

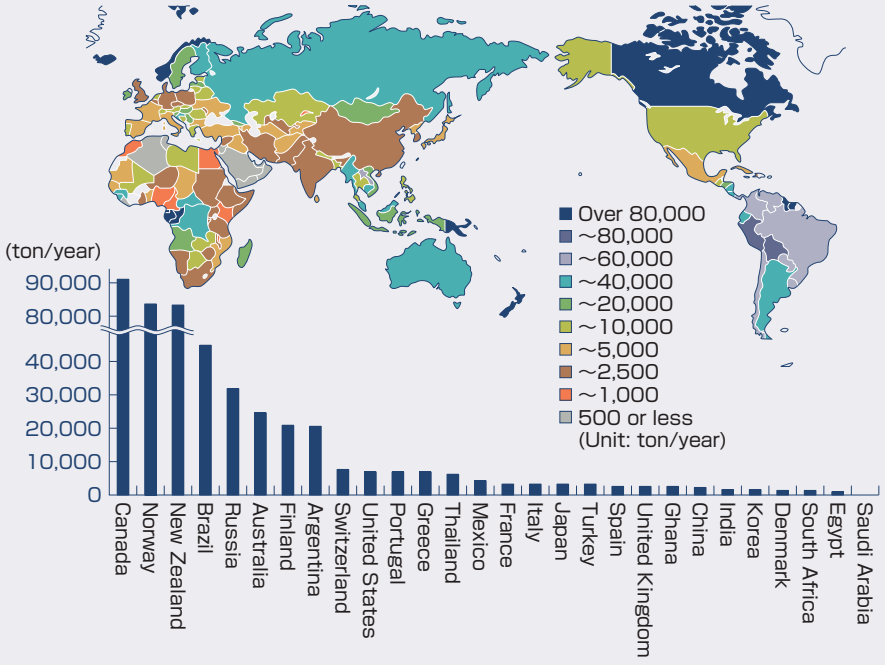
Due to the uneven distribution or depletion of water resources, the availability of water is becoming a constraint on economic development, making it necessary to make a considerable amount of investment to secure a sufficient supply of water.

Figure Int.-2-8 The World's Water Utilization Volume by Sector



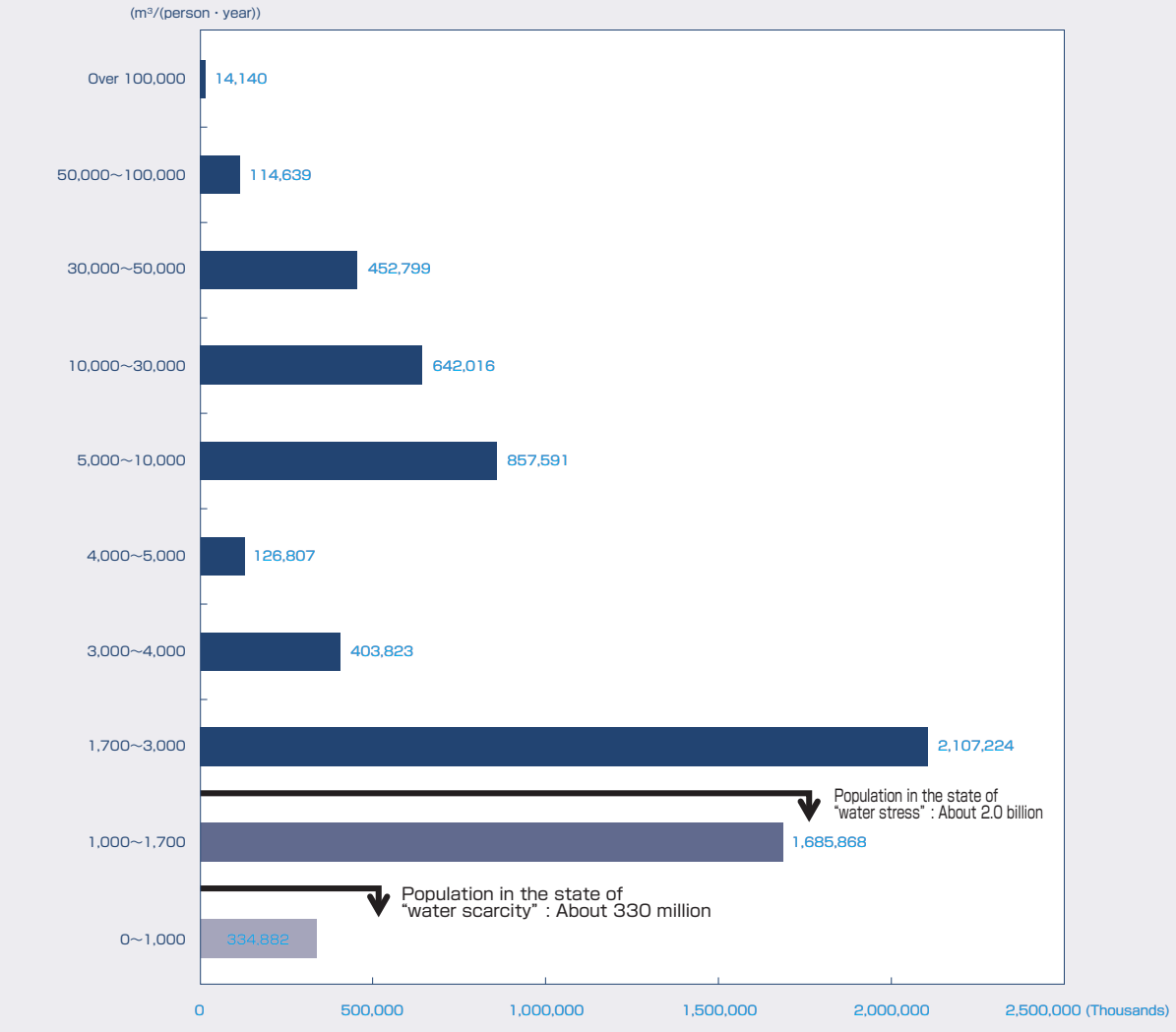
Source: WWF "Living Planet Report 2006"

Figure Int.-2-9 Annual Per-Capita Water Resources in the World



Source: Prepared by the Ministry of the Environment based on FAO AQUASTAT (2008.1.16)

Figure Int.-2-10 Per-Capita Water Resources and Population (2008)



Source: Prepared by the Ministry of the Environment based on FAO AQUASTAT Database

(3) Food: increasing demand for food and tightening supply-demand

A: Supply and demand trends of grains

Demand for grains that support the subsistence of human increases in association with an increase in population. More specifically, against the backdrop of demand increases in proportion to the increase in population and increased demand for livestock products and fats reflecting higher income levels, demand for grains has expanded 1.8 times from 1.1 billion tons in 1970 to 2.1 billion tons in 2007.

Production of cereal crops has been increasing by and large in accordance with demand for food. Over the past five decades, production of agricultural products has met increased demand by raising unit crop yields while harvested areas have stayed almost flat. In recent years, however, the quantity of production has not risen much as the growth of unit crop yields slowed, while drought and poor crops in major grain-growing areas also affected production. When a substantial expansion of crop harvested areas cannot be expected, there are concerns that slowing rises in unit crop yields and the ongoing global warming and desertification may seriously affect food production going forward.

Until recently, the supply-demand balance of grains has been maintained as production increased in response to increasing demand for food, with the occasional oversupply or short supply being adjusted by year-end stocks. In recent years, however, production has dipped due to poor harvests of major crops for successive years while demand for grains has been on the steady rise, resulting in the drop in the year-end stock-to-sales ratio to 15.0%, the lowest level since the food crisis in the early 1970s and lower than the 17-18% safe inventory levels set by the U.N. Food and Agriculture Organization (FAO).

Going forward, while demand for food may increase faster than previously estimated, unless production is steadily expanded, food supply-demand could tighten considerably, sending already rising prices of farm products to even higher levels.

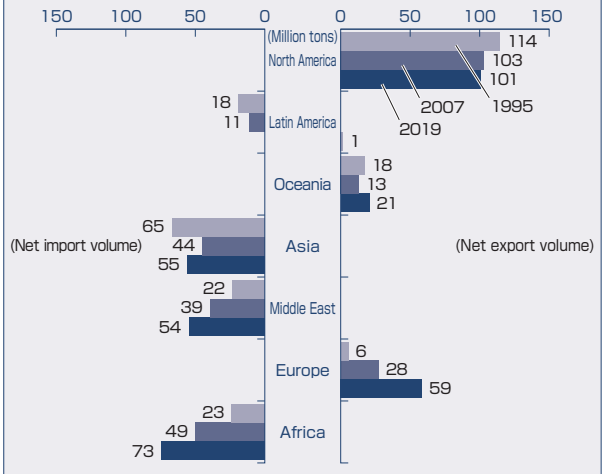
According to grain trade volume projections (net export volume and net import volume) by region, net import volumes are expected to increase for Africa, Asia and the Middle East between 2007 and 2019,

while Europe and Oceania are seen to expand their net export volumes (Figure Int.-2-11). North America, meanwhile, is likely to see a decline in net export volumes between 1995 and 2019, but will remain as the world's major net grain exporting region. Reflecting the growing uneven distribution of food producing and exporting countries amid globalization, any change in the supply and demand situation could have no small impact on international prices, giving rise to concerns that price rises can be amplified easily by anxiety-driven export restrictions or an inflow of speculative money into grain markets.

Next, Japan's food self-sufficiency rate has been on the decline over the past several decades. The self-sufficiency rate in food on a calorie basis has dropped from 78% in FY1961 to around 40% in recent years, presumably influenced by the shift in dietary habits from Japanese to Western-style food (Figure Int.-2-12). Meanwhile, in contrast to the case of Japan, the United Kingdom has raised its food self-sufficiency. While food self-sufficiency rate of UK has been dropping in recent years, it had risen from 42% in 1961 to 70% in 1993. Relatively high self-sufficiency of UK in food is described as reflecting that land in the country is flat to make efficient agricultural production possible and that production of wheat and some other crops has increased thanks to farm subsidies it is getting through accession to the European Community (EC).

The sharp rises in grain prices from 2007 to 2008 are said to have stemmed from increased demand for grains in developing countries, expanding demand for grains as materials for bio fuels, the dwindled supply due to drought and higher speculative demand as well as grain export bans or restrictions imposed by major exporters including China and Russia after price increases in international markets. As seen above, once the supply-demand tightens, it is possible for grain-exporting countries to go for "enclosure" of cereal crops. Thus, it is necessary for Japan, which depends on foreign suppliers for 60% of food, to proactively seek to raise the food self-sufficiency rate, by basically increasing domestic production and under the national policy of combining domestic supply with imports and stockpiles appropriately. In addition, some 19 million tons of food are being discarded each year, an amount that is about six times the food aid of 3.3 million tons provided by the U.N. World Food Programme (WFP) in 2007.

Figure Int.-2-11 Projected Grain Trade Volume (Net Export/Inport Volume) by Region



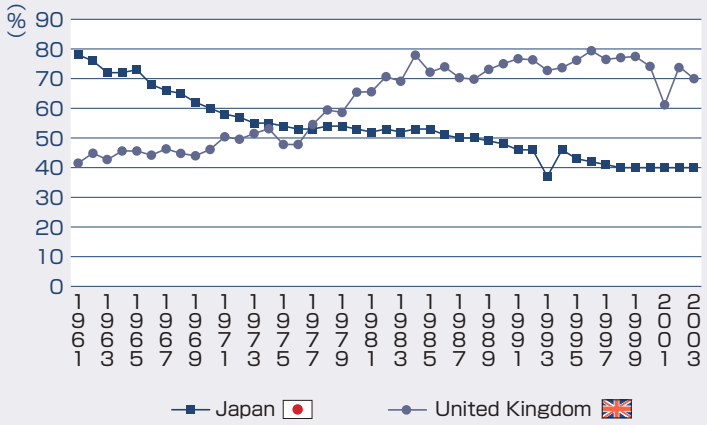
Note: Net export and import volumes do not include intra-regional trade volumes.
Source: Ministry of Agriculture, Forestry and Fisheries, "World Food Supply and Demand Projections to 2019 -World Food Supply and Demand Model projection Results-"

B: Supply and demand trends of seafood

With the increase in per-capita demand combining with the population growth, global demand for seafood doubled from 56.28 million tons in 1970 to 126.00 million tons in 2003, and in particular, China's demand shot up 11.7 times from 4.05 million tons to 47.56 million tons during the same period. Also, global per-capital demand for fish and shellfish for food grew 1.5 times from 11.1 kg in 1970 to 16.1 kg in 2003. By major country and region, per-capita demand grew 1.4 times in the United States, 1.3 times in the European Union (EU) and 5.7 times in China.

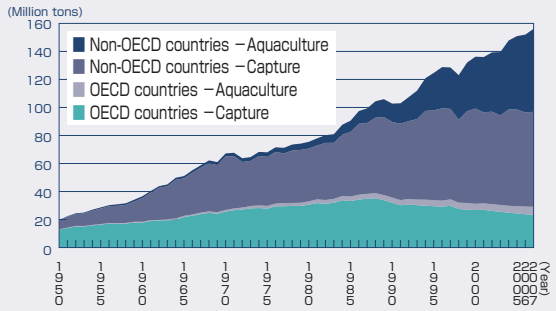
Going forward, global demand for seafood is expected to increase with the growth of population and rising income. Particularly in China, where fish and shellfish are regarded as more luxurious than beef and other meat, demand for seafood is likely to increase in tandem with higher income. Together with this, the

Figure Int.-2-12 Trends in the Calorie-Based Food Self-Sufficiency Rate of Japan and United Kingdom (1961-2003)



Source: Prepared by the Ministry of the Environment based on the Ministry of Agriculture, Forestry and Fisheries, "Food Supply-Demand Table (FY2007)"

Figure Int.-2-13 Global Trends of Fishery Production (1950-2007)

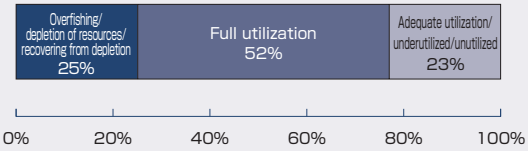


Note: Excludes aquatic mammals and miscellaneous aquatic animals
Source: Prepared by the Ministry of the Environment based on FAOSTAT Database

broadening markets for seafood associated with improved distribution infrastructures and enhanced processing and refrigeration technology, including revamped road and other transportation networks, upgraded processing techniques and the deployment of processing plants, freezing and refrigeration facilities, are also helping increase demand. In Asia as well, demand for seafood is projected to rise thanks to rising levels of income.

The quantity of production (supply) of seafood has risen in response to increased demand, mainly supported by increased aquaculture, while fish capture peaked out at around 90 million tons in the 1990s (Figure Int.-2-13). Cultured fishery accounted for 40% of the 2007 seafood production of 156.00 million tons. Comparison of fishery production between member states of the Organization for Economic Cooperation and Development (OECD) and non-OECD countries indicates that while fishery production of OECD economies has declined, that of non-OECD countries increased, with their aquaculture sectors expanding production remarkably in recent years (Figure Int.-2-13). Looking at fishery production by country, China produced 60.63 million tons of seafood in 2005 to

Figure Int.-2-14 Utilization of Fishery Resources (2005)



Source: FAO "Review of the State of World Marine Fishery Resources"

become the world's largest producer, accounting for 40% of global production for the year. And aquaculture accounts for as much as 70% of Chinese seafood production, with inland water fish culture involving the development and diversion of tidal flat expanding.

A FAO (Food and Agriculture Organization) survey on the utilization of fishery resources shows that about half of marine fishery resources are fully utilized, while one-fourth is in the state of overfishing due to indiscriminate fishing (Figure Int.-2-14). As fish captures are likely to remain stagnant going forward, production increases are expected to depend on aquaculture.

With demand for seafood increasing globally, the supply and demand balance is tightening and some fish and shellfish prices are showing an upward trend. According to FAO, while seafood production, led by fish culturing, is likely to increase in response to expanding demand in association with the population growth and rising income, demand is expected to overtake production potentially amid limited fishery resources. Under these circumstances, the supply and demand of seafood are likely to be balanced ultimately through higher prices and the shift to other protein food. Demand for seafood is projected to increase 1.4 times from an average 130 million tons for 1999-2001 to 180 million tons by 2015, while prices are forecast to rise at an annual rate of 3.0% by 2010 and then at an annual rate of 3.2% through 2015.

(4) Energy: an increase in energy demand and the accelerating utilization of renewable energy

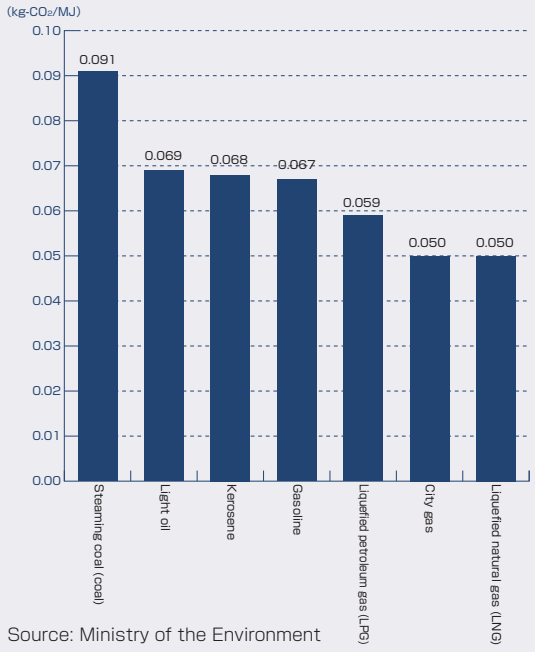
Energy consumption, which is closely linked to the environmental load through carbon dioxide emissions, is believed to follow an upward trend in the long run. The International Energy Agency (IEA) estimates that global energy consumption in 2009 almost certainly declined as a result of the financial and economic crisis, but if current energy policies are kept intact, energy consumption will get back on the long-term uptrend once the economy recovers.

Global primary energy consumption more than doubled in less than 40 years, from 5.5 billion tons of oil equivalent (TOE) in 1971 to 12.0 billion TOE in 2007 (Figure Int.-2-15). As the global economy is expected to grow going forward, led by emerging economies, energy consumption will likely remain on the increase. By energy source, petroleum accounts for about one-third of energy consumption. The IEA estimates that if governments around the world keep their existing energy policies and measures intact, fossil fuels still account for the bulk of primary energy sources and over three-fourths of the increase in energy consumption projected between 2007 and 2030 would come from fossil fuels (Figure Int.-2-15). Furthermore, the IEA expects demand for coal, among fossil fuels, to grow considerably in the future due to expanding demand for electric power generation. Given that the use of coal discharges more carbon dioxide than other energy sources (Figure Int.-2-16), there is concern that the environmental load would further increase unless active efforts are exerted toward more sophisticated use of fossil fuels.

Amid the expectation that global energy consumption will keep growing going forward, renewable energy, which emits less carbon dioxide than fossil fuels, is gaining in importance. Global demand for renewable energy is estimated to grow to 2.38 billion TOE in 2030 from 1.52 billion TOE in 2008 (Figure Int.-2-15). Countries in the world are moving to more proactively utilize renewable energy, setting goals of raising the ratio of renewable energy to total energy consumption and supply (Table Int.-2-1).

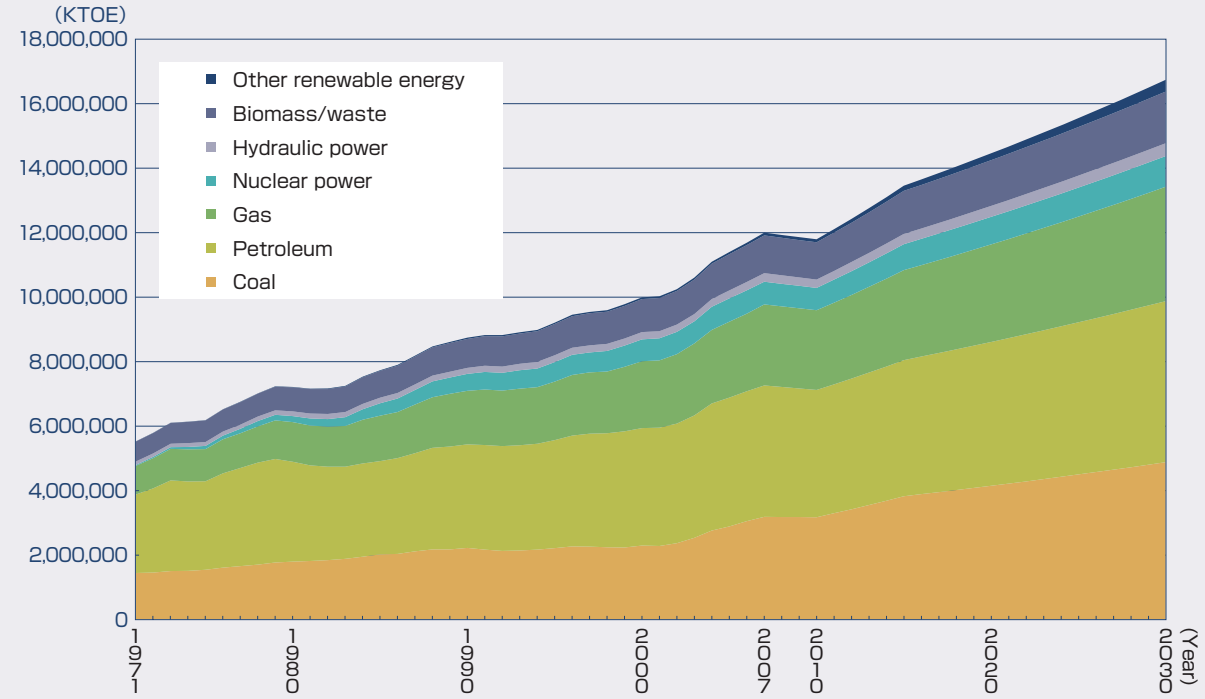
Japan's domestic primary energy supply increased

Figure Int.-2-16 Carbon Dioxide Emission Factor of Major Fuels



Source: Ministry of the Environment

Figure Int.-2-15 World Primary Energy Demand Outlook



Source: Prepared by the Ministry of the Environment based on IEA, "World Energy Outlook 2009" Energy Balance Table

around 3.6 times between 1965 and 2007. Looking at a share of each energy source in the domestic primary energy supply, the dependence on oil has declined in recent years and natural gas instead increased the share in energy supply (Figure Int.-2-17). The component ratio of hydropower and new energy, geothermal power, etc., primarily comprising renewable energy (excluding private power generation of 1,000 kw or less), has not changed much since 1990.

Regarding Japan's future energy supply, the government is currently reviewing the Basic Energy Plan by taking into account measures to cope with global warming and the new growth strategy.

Table Int.-2-1 List of Renewable Energy Introduction Targets for 2020

Country	Ratio of renewable energy	
	2005-2006 results	2020 targets
Denmark＊	17%	30%
Germany＊	6%	18%
Spain＊	9%	20%
France＊	10%	23%
Italy＊	5%	17%
Netherlands＊	2%	14%
Austria＊	23%	34%
Finland＊	29%	38%
Sweden＊	40%	49%
United Kingdom＊	1%	15%
Total for 27 EU member states＊	9%	20%
China	8%	15%
Egypt	4%	14%
Brazil	43%	—
India	31%	—
Indonesia	3%	15% (by 2025)
Thailand	4%	8% (by 2011)
Japan	3%	—
Korea	1%	5% (by 2011)
United States	5%	—
Canada	16%	—

Note: Figures for EU countries states are marked with the 2005 results for the ratio of renewable energy to final energy consumption.
Figures for other countries are the 2006 results for the ratio of renewable energy to the primary energy supply.
Source: Prepared by the Ministry of the Environment based on a document adopted by European Parliament and "Renewables 2007 Global Status Report"

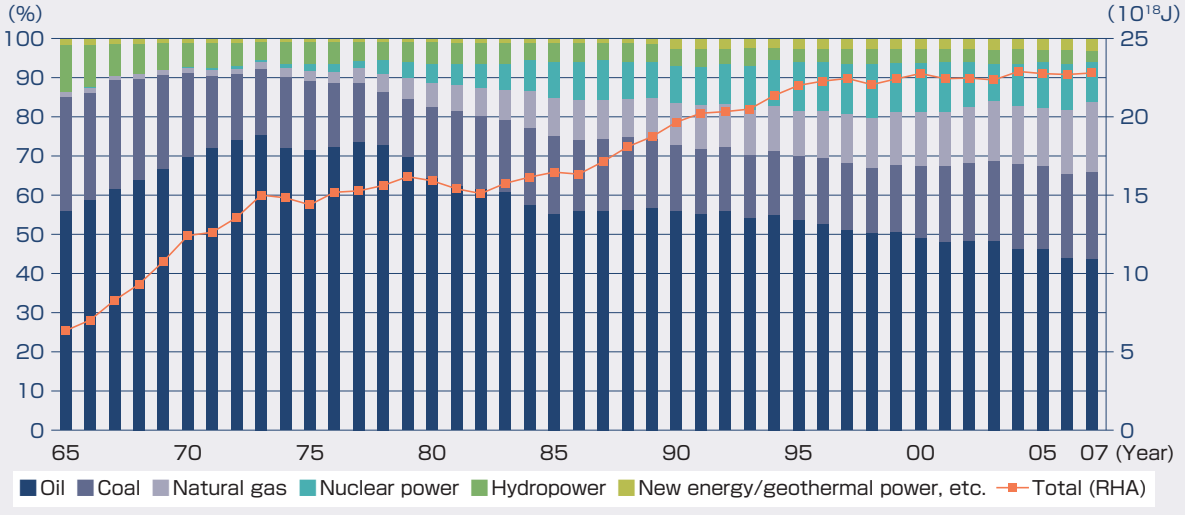
(5) Land: progression of deforestation and desertification

The population growth and the resultant increase in production activities have brought about major changes in land use. The Millennium Ecosystem Assessment (MA) report noted the cultivation of about one-fourth of all land on the earth as the biggest change in the ecosystem structure, and pointed out that more land has been cultivated during the 30 years from 1950 than in the 150 years between 1700 and 1850. As of 2005, 12% of all land area was in use as farmland, an increase of some 1.7 percentage points over 2000.

While land for agricultural use has increased, the forest area has dwindled markedly. According to the U.N. Environment Program (UNEP), since the arrival of the climate of the modern age, around half of the original forests that existed since before the spread of the impact of humans disappeared due to human activities (Figure Int.-2-18). Given that the remnant forests cover about 30% of the total land area, we can assume that from the viewpoint of forest exploitation alone, forests equivalent to about 30% of the total land area have been utilized and lost. UNEP traces this loss of forests to human activities, including agriculture, raising livestock and tree trimming for lumber and fuel as well as the expansion of densely-populated areas.

Going forward, if meat and fish are more favored in dietary habits as income levels rise in tandem with economic growth of developing countries, more land and water resources become necessary than production

Figure Int.-2-17 Trends of Japan's Total Primary Energy Supply



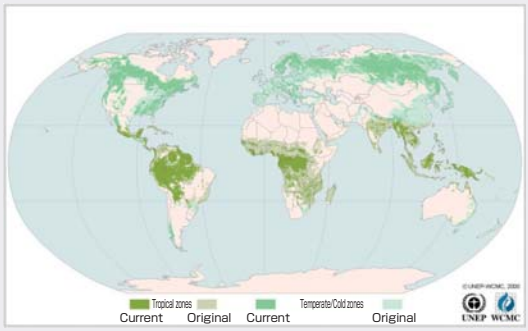
Note 1: The calculation method for figures in Comprehensive Energy Statistics was changed in FY1990.
2: Comprehensive Energy Statistics does not cover private power generation of 1,000 kw or less.
Source: Prepared by the Ministry of the Environment based on the Agency for Natural Resources and Energy, "Comprehensive Energy Statistics"

of cereal crops and other agricultural products, raising concerns about greater burdens on the environment. For example, production of meat consumes more land, water and other resources than production of grains and other agricultural products. Looking at land area required for food production, in terms of per one kg of protein, land area needed for production of chicken is about 7 times, pork about 12 times and beef about 20 times larger than land area required for production of cereal crops (Figure Int.-2-19). Thus, higher income levels in developing countries and resultant changes in dietary habits may require the utilization of more land and resources on the earth than before in the future.

Desertification is also cited as a global environmental issue related to land degradation. Dryland vulnerable to desertification occupy 41% of Earth's land area, and are home to more than 2.0 billion people, at least 90% of who lives in developing countries (Figure Int.-2-20). Desertification is said to be caused by climatic variations such as climate change, drought and moisture loss on a global level as well as human activities including overgrazing, deforestation and removal of the natural vegetation cover (by taking too much fuel wood), agricultural activities in the vulnerable ecosystems of arid and semi-arid areas, which are thus strained beyond their capacity.

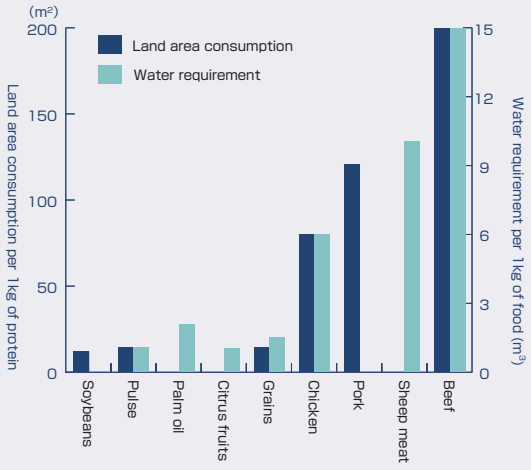
Desertification is also the source of concern over food insecurity, water scarcity and poverty. The further exacerbation of desertification through population growth, increase in urbanization and the impact of the market economy are feared to aggravate

Figure Int.-2-18 Global Distribution of Remnant Original Forests



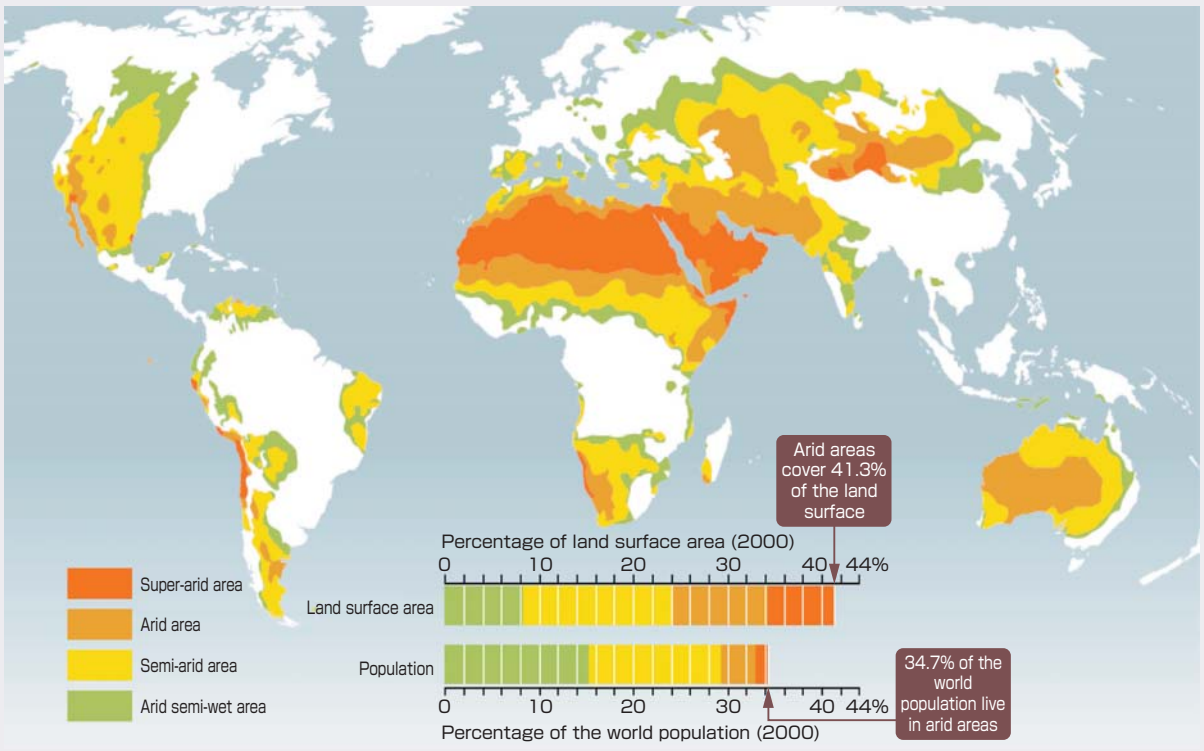
Source: UNEP-WCMC

Figure Int.-2-19 Land and Water Consumption by Food Item



Source: "The Economics of Ecosystems & Biodiversity (TEEB)" (An Interim Report)

Figure Int.-2-20 Global Distribution of Arid Areas



Source: Millennium Ecosystem Assessment (2005)

Table Int.-2-2 Trends of the Distribution of Land Use in Japan

(Unit:10,000 ha)

	1965	1972	1975	1980	1985	1990	1995	2000	2005	2007	1965~2007 Increase/decrease in area
Agriculture	643	599	576	561	548	534	513	491	478	473	−170
Forestry	2516	2523	2529	2526	2530	2524	2514	2511	2510	2506	−10
Field	64	56	43	33	31	27	24	27	28	28	−36
Surface water,rivers,water channels	111	112	128	115	130	132	132	135	134	133	22
Roads	82	91	89	104	107	114	121	127	132	134	52
Urban	85	111	124	140	150	161	170	179	185	187	102
Other	270	282	286	298	282	285	302	309	312	316	46

Source: Prepared by the Ministry of the Environment based on the Ministry of Land, Infrastructure, Transport and Tourism, "Monitoring of national-land circumstances" and "White Paper on Land"

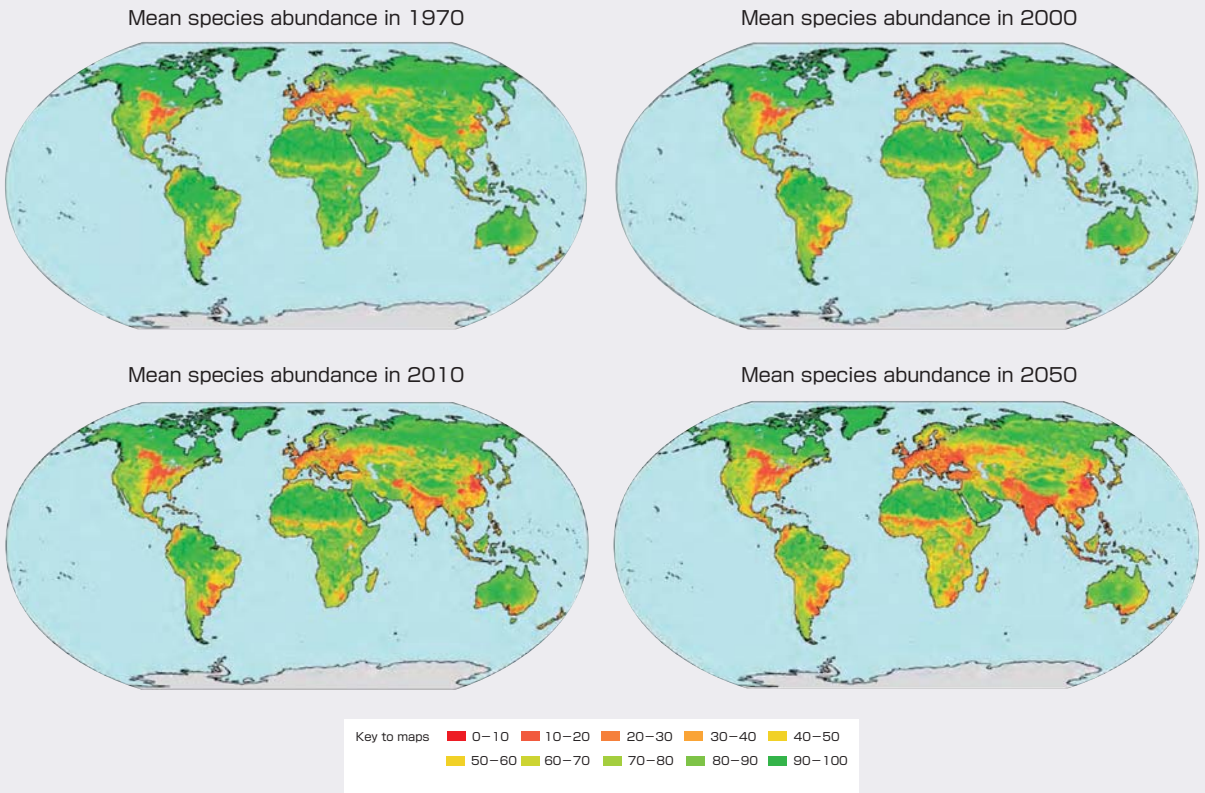
social uncertainties.

Looking at the trends of land use in Japan, the area of agricultural land has decreased, while areas of residential land and roads have increased. Comparison of land areas by use between 1965 and 2007 reveals that agricultural land decreased by 1.70 million hectares, or about 26%, while residential land and roads increased by 1.02 million hectares, or 120%, and 520,000 hectares, or 63%, respectively. As these figures shows, in Japan since 1965, the shrinkage in the area of agricultural land and the expansion of areas of residential land and roads are obvious. While these trends continue in recent years, the areas of conversion from agroforestry land use (farmland, forestry and reclaimed land) to urban land use (residential land, public land and land for industrial use) have been on the decrease, indicating the slowing trend in the conversion of land use from agricultural land to residential land and roads that was so evident in the past.

(6) Biodiversity: progressive loss of biodiversity

According to an interim report of the Economics of Ecosystems & Biodiversity (TEEB), released at the high-level segment of the ninth meeting of the Conference of the Parties to the Convention on Biological Diversity (COP9) in 2008, only about 73% of the original global natural biodiversity was left by the year 2000, and the strongest declines in biodiversity have occurred in the temperate and tropical grasslands and forests, where human civilizations first developed. The report also said, "A further 11% of land biodiversity is expected to be lost by 2050 … In some biomes and regions, projected losses are about 20%." The TEEB interim report cited the continued conversion of natural areas to agricultural land, the ongoing expansion of infrastructure and increasing effects of climate change as additional major contributors to biodiversity loss, and said: "For the

Figure Int.-2-21 Mean Species Abundance in the World (1970, 2000, 2010 and 2050)



Source: "The Economics of Ecosystems & Biodiversity (TEEB)" (An Interim Report)

world as a whole, the loss of natural areas over the period 2000 to 2050 is projected to be 7.5 million square kilometers … i.e. the size of Australia."

Measuring the loss of biodiversity by the MSA (mean species abundance) indicator, the report said that between 1970, 2000, 2010 and 2050, major impacts are expected in Africa, India, China and Europe (Figure Int.-2-21).

Coral reefs are one of the ecosystems mostly likely to be damaged seriously by human activities. According to an analysis announced by the International Union for the Conservation of Nature (IUCN) in 2009, the "Red List Index" (the index for the extinction risk of species shows the percentage of species likely to continue to exist without taking further action in the near future. Value 1 indicates all species are classified into "Least Concern" , while value 0 indicates all species are classified into "Extinct") for coral reefs deteriorated rapidly since 1996, due chiefly to bleaching that occurred in 1998 (Figure Int.-2-22). The analysis also said the coral bleaching is now occurring more frequently and over an extended period, and is related to rising sea temperatures, a symptom of global climate change.

Similarly, according to the summary version of TEEB for Policy Makers released in 2009, over 20% of coral reefs are already "seriously degraded or under imminent risk of collapse" as a result of human activities, including coastal development and over-fishing. The report, citing recent research, pointed out that, in the decades ahead, coral reefs may be reduced to half or even become extinct due to global warming and ocean acidification, adding that the long-term survival of coral reefs would depend on major reductions in carbon dioxide emissions together with a reduction in local burdens on the environment. The TEEB summary version said in order to cope with the crisis situation of coral reefs, strong policy action by the public sector is necessary and measures should be taken by taking into account social fairness, the impact on ecosystems and economic efficiency.

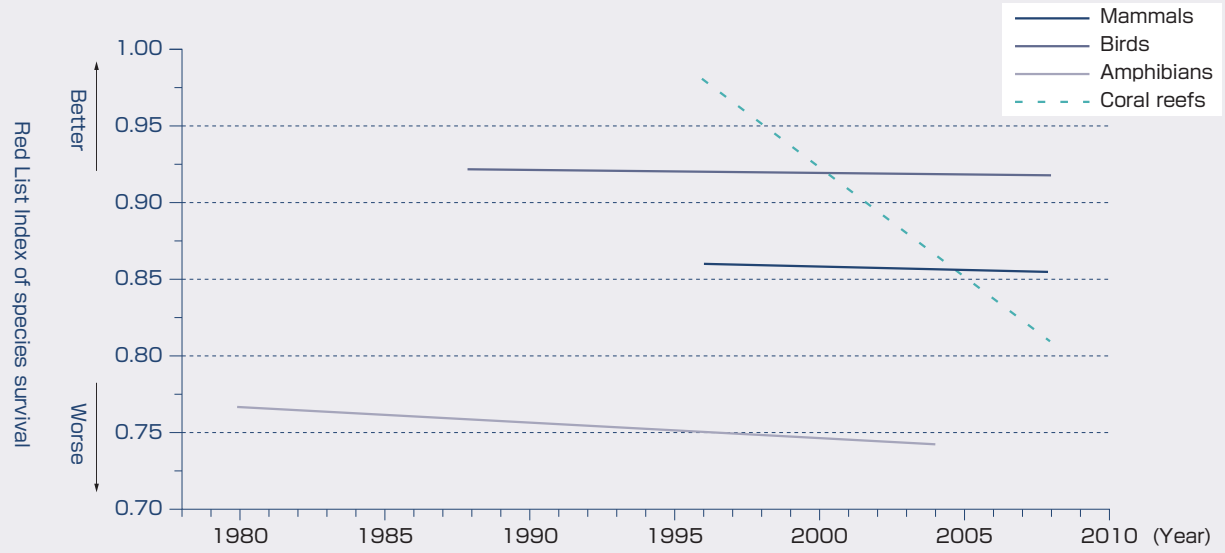
The circumstance of biodiversity in Japan appears in chapter 1.

(7) Recyclable resource and wastes: unstable markets and increasing wastes

The amount of resources used in 2004 (almost equivalent to the amount of rocks mined annually) came to about 22.0 billion tons globally, with an annual increase of 560 million tons since 1990 topping the annual increase of 380 million tons in the 1960-1970s, when the crisis of resources depletion was much talked about (Figure Int.-2-23). While the reserve-production ratio varies for major metal resources, such as 32 years for copper, 73 years for iron ores and 771 years for aluminum, the ratio for some resources is limited. As for rare metals for which demand is expected to increase in coming years for use in products such as lithium ion batteries and transparent electrodes for liquid crystal panels, some have only limited resources, with the reserve-production ratio standing at 47 years for lithium, 51 years for indium and 392 years for platinum. Furthermore, these rare metal resources are unevenly distributed geographically (Table Int.-2-3), and thus further efforts for efficient use of resources are necessary to ensure a stable supply of resources. According to the National Institute for Materials Science (NIMS), even if all the countries in the world matched Japan in terms of conservation of resources, demand for resources will most likely exceed the amount of reserves by 2050 (Figure Int.-2-24).

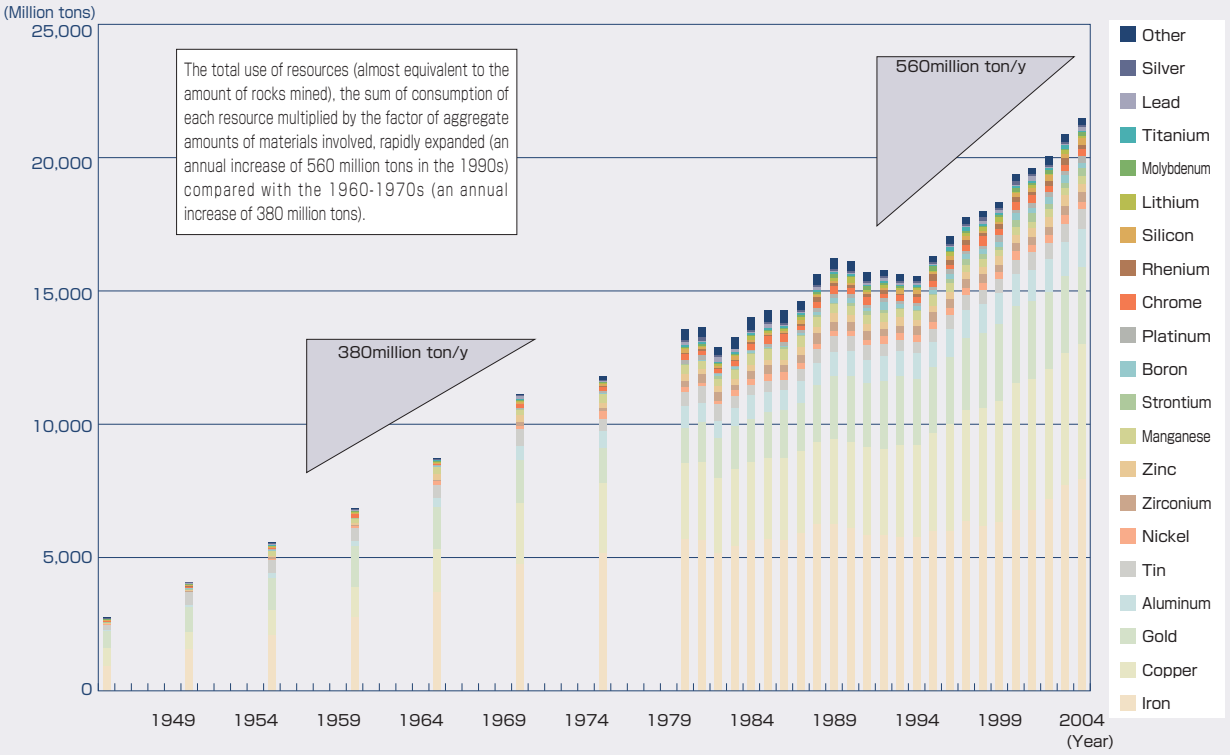
Pushing ahead for a sound material-cycle society should lead to the stable supply of resources. Trends of resource prices in the past decade indicate particularly large fluctuations in resource prices (Figure Int.-2-25). These price fluctuations greatly affect the economy through surges in import prices and

Figure Int.-2-22 Trends of Red List Index (Mammals, Birds, Amphibians and Coral Reefs)



Source: IUCN, "Wildlife in a Changing World"

Figure Int.-2-23 Trends of Total Use of Resources



Source: National Institute for Materials Science press release "Sustainable Utilization of Resources Requires Reduction of Total Use of Resources to One-Eighth"

Table Int.-2-3 Uneven Distribution of Nonferrous Metal Resources

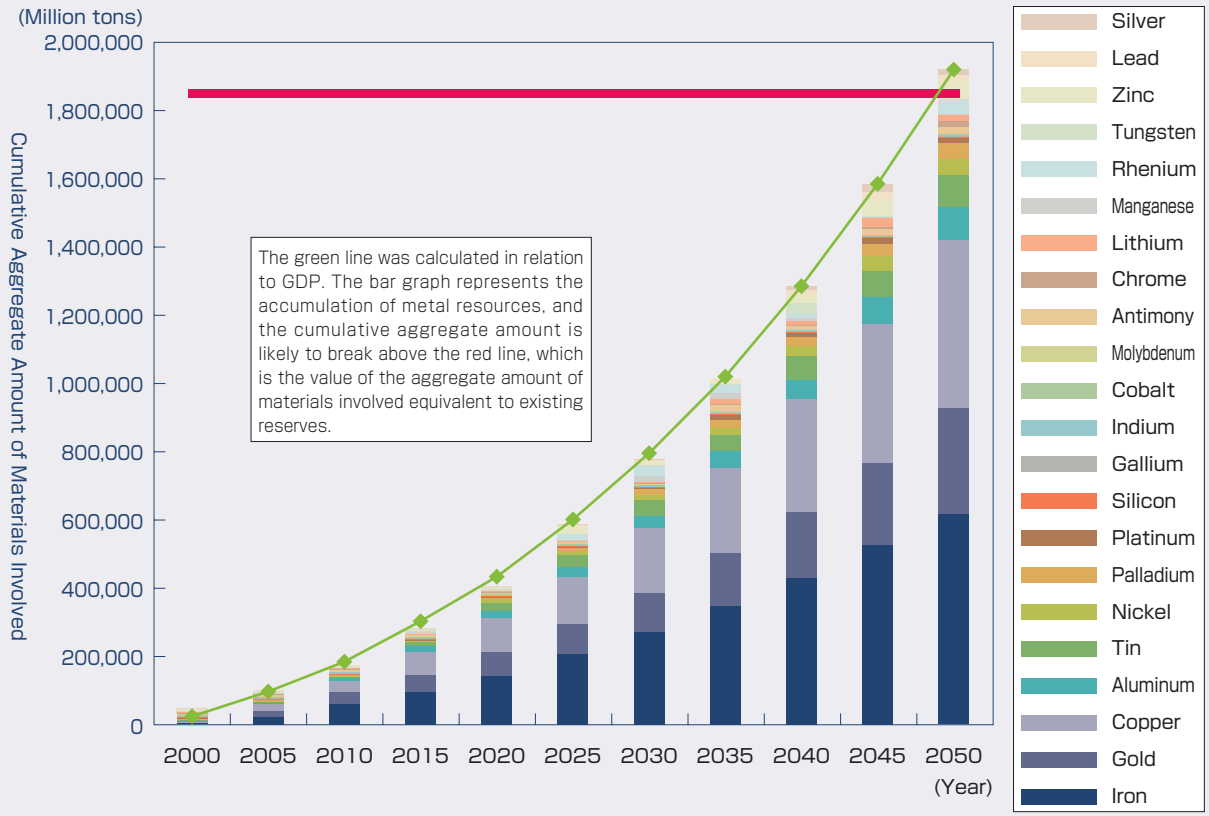
	Major Producers of Resources (Mineral Ores) (2009)						Combined Share of the Top Three Producers
Resource	First		Second		Third		
Rare earth metals	China	97%	India	2%	Brazil	1%	99%
Vanadium	China	37%	South Africa	35%	Russia	26%	98%
Platinum	South Africa	79%	Russia	11%	Zimbabwe	3%	93%
Tungsten	China	81%	Russia	4%	Canada	3%	89%
Molybdenum	China	39%	U.S.	25%	Chile	16%	80%
Lithium Note 1	Chile	41%	Australia	24%	China	13%	78%
Indium Note 2	China	50%	Korea	14%	Japan	10%	74%
Lead	China	43%	Australia	13%	U.S.	10%	67%
Cobalt	Congo	40%	Australia	10%	China/Russia	10%	60%
Manganese	China	25%	Australia	17%	South Africa	14%	55%
Zinc	China	25%	Peru	13%	Australia	12%	50%
Copper	Chile	34%	Peru	8%	U.S.	8%	49%
Nickel	Russia	19%	Indonesia	13%	Canada	13%	44%

Note 1: The share excludes production in U.S. (unknown).
2: The share is based on refinery production.
Source: Prepared by the Ministry of the Environment based on U.S. Geological Survey, "Mineral Commodity Summaries 2010"

resultant hikes in prices of various commodities. Because Japan is heavily dependent on imported resources, it is necessary to promote a sound material-cycle society and strive to secure a stable supply of resources in order to reduce risks associated with resource price fluctuations and ensure the economic stability.

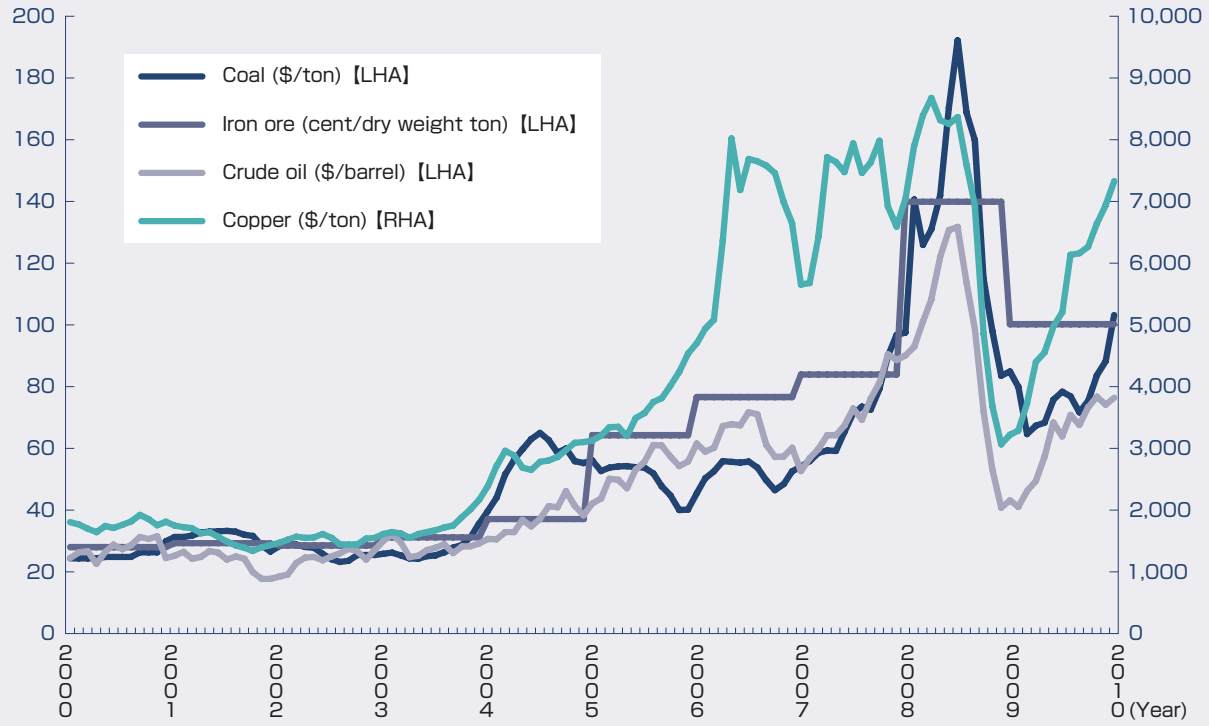
According to future projections of total global generation of wastes, total waste generation amount to about 27.0 billion tons in 2050, about 2.1 times of some 12.7 billion tons in 2000. Thus, wastes are likely to increase faster than the global population during the same period, which is projected to rise about 1.5 times (Figure Int.-2-26). Per-capita waste generation is also estimated to increase about 1.4 times to 2.9 tons in 2050 from some 2.1 tons in 2000. Since the continued increase in per-capita waste generation means inefficient utilization of limited resources and heavier burdens on the environment, it is necessary to push ahead with efforts on a global scale to build a sound material-cycle society by reducing wastes and utilizing resources more efficiently.

Figure Int.-2-24 Cumulative Aggregate Amount of Materials Involved



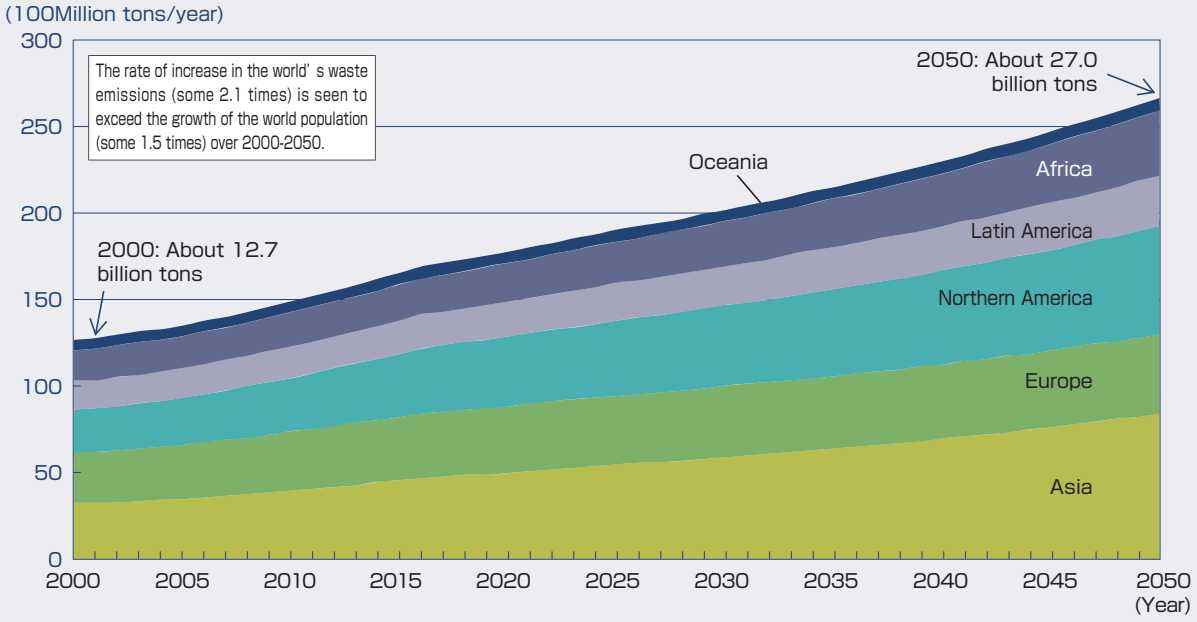
Source: National Institute for Materials Science press release "Sustainable Utilization of Resources Requires Reduction of Total Use of Resources to One-Eighth"

Figure Int.-2-25 Trends of Resources Prices



Source: Prepared by the Ministry of the Environment based on IMF, "Primary Commodity Prices"

Figure Int.-2-26 Future Projections of the World' s Waste Emissions (2000-2050)



Source: Saeko Yoshizawa, Masaru Tanaka and Ashok V.Shekdar, "Research on Estimation of Global Waste Generation and Future Projections"

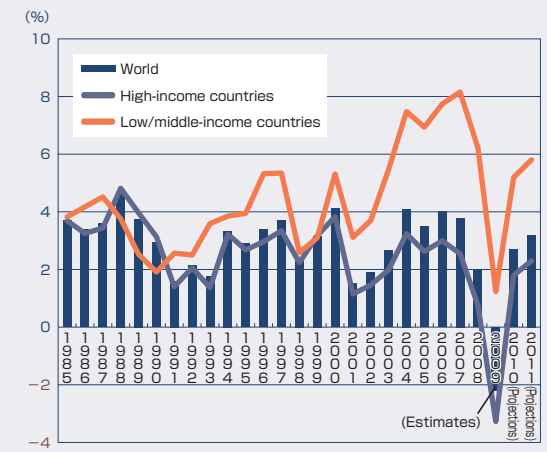
(8) Trends of economic activities: instability of the existing economic system and the shift of economic center to Asia

The world economy is estimated to have incurred negative growth in 2009, in the aftermath of the subprime loan problem in the United States in 2007 and the subsequent collapse of a major U.S. investment bank in 2008. The fundamental causes of the financial crisis has been traced to the vulnerability of the financial system brought about by a combination of inadequate risk management practices, complex and opaque financial instruments and excessive leverage, on top of market participants' failure to appropriately assess risks involved and conduct adequate due diligence. In response to the global economic crisis, touched off by the financial crisis, countries around the world strove to tide over the severe situation by actively making environment-related investments, a move in the direction of the so-called Green New Deal.

The world economy is expected to get back on the path of positive growth from 2010 onward. According to projections by the World Bank, the global economy, in terms of real gross domestic product (GDP), is estimated to have posted negative growth in 2009 in the wake of the worst recession since the end of World War II, but is likely to go into a period of positive growth in 2010 and onward (Figure Int.-2-27). Looking at the trends of economic growth by the two categories of high-income and low/middle-income countries, low/middle-income countries have had registered economic growth higher than high-income countries since 2000. This trend is expected to continue at least until 2011.

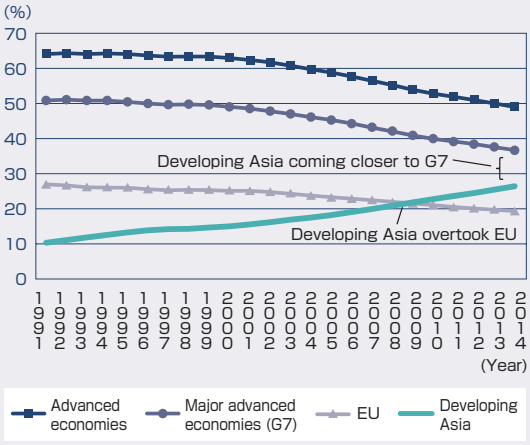
Following the high growth of low/middle-income countries, the GDP shares by each region and group in the global economy have undergone major changes. The group of developing countries in Asia, including China, has seen its share in the global economy increase remarkably and this trend is seen likely to persist going forward. On the other hand, the shares of the Group of Seven (G7) countries, developed countries as a whole and the EU have dwindled sharply (Figure Int.-2-28). All these developments, without doubt, indicate that the economic gravity is shifting to Asia. Considering that economic development in the past has been achieved by imposing burdens on the environment, the importance of environmental measures in Asia will increase more than ever going forward.

Figure Int.-2-27 Comparison of GDP Growth by Income



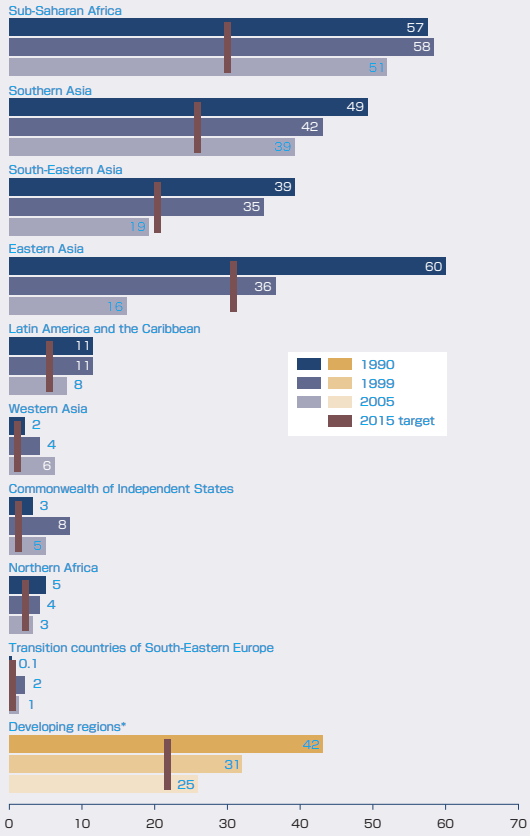
Source: Prepared by the Ministry of the Environment based on the World Bank, "World Development Indicators" and "Prospects for Developing Economies"

Figure Int.-2-28 Trends of Global GDP Shares of Region/Group



Note: "Advanced economies," "Major advanced economies(G7)," "EU" and "Developing Asia" are based on the definitions of the IMF
Source: Prepared by the Ministry of the Environment based on IMF, "World Economic Outlook Database, October 2009"

Figure Int.-2-29 Proportion of People Living on less than $1.25 a Day (%, 1990, 1999 and 2005)



* Includes all developing regions, the Commonwealth of Independent States and transition coutries of South-Eastern Europe

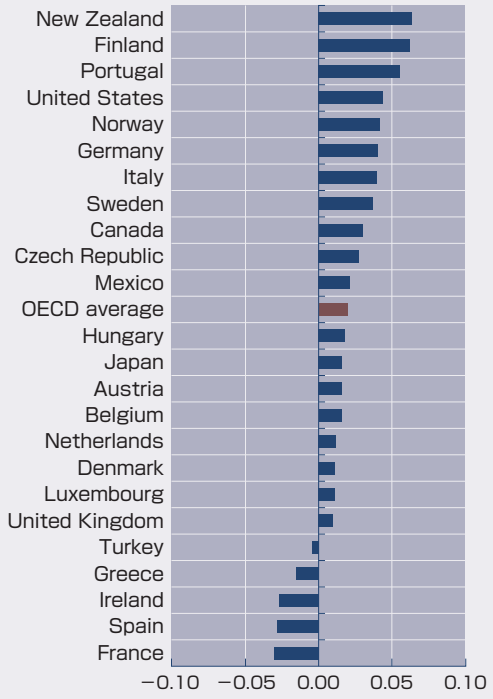
Source: United Nations, "The Millennium Development Goals Report 2009"

Table Int.-2-4 Comparison of Income Disparity in the Mid-2000s

	Gini coefficient		Gini coefficient
Denmark	0.23	Australia	0.30
Sweden	0.23	Korea	0.31
Luxembourg	0.26	Canada	0.32
Austria	0.27	Spain	0.32
Czech Republic	0.27	Japan	0.32
Slovakia	0.27	Greece	0.32
Finland	0.27	Ireland	0.33
Netherlands	0.27	New Zealand	0.34
Belgium	0.27	United Kingdom	0.34
Switzerland	0.28	Italy	0.35
Norway	0.28	Poland	0.37
Iceland	0.28	United States	0.38
France	0.28	Portugal	0.42
Hungary	0.29	Turkey	0.43
Germany	0.30	Mexico	0.47
		OECD average	0.31

Source: Prepared by the Ministry of the Environment based on OECD, "OECD Factbook 2009"

Figure Int.-2-30 Changes in Gini Coefficient of OECD Member States from the Mid-1980s to the mid-2000s



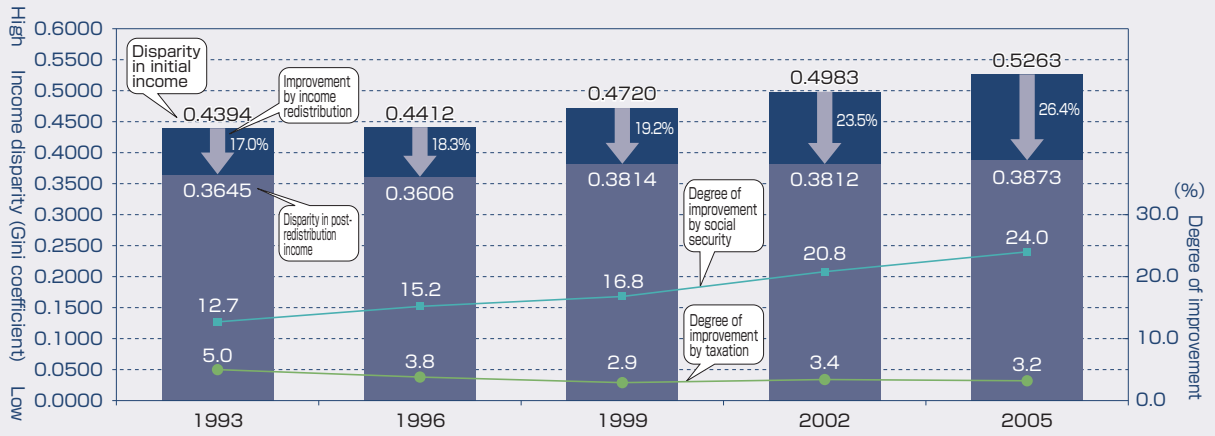
Source: Prepared by the Ministry of the Environment based on OECD, "OECD Factbook 2009"

(9) Trends of poverty and economic gaps: the importance of economic growth differs depending on the development stage

According to a U.N. report on the poverty situation in the world, people in developing countries living in dire poverty under $1.25 a day (2005 price levels) decreased to 1.4 billion in 2005 from 1.8 billion in 1990. As a result, the percentage of people in dire poverty has declined to about one-fourth of the total population of developing countries in 2005 from about half in 1990(Figure Int.-2-29).

In terms of trends of the poverty rate and the population in poverty by region, the poverty rate in Eastern Asia has shown a dramatic decline between 1990 and 2005, mainly thanks to the rapid economic growth in China, and this is believed to have lifted 475 million people out of dire poverty. In sub-Saharan Africa, on the other hand, the population in dire

Figure Int.-2-31 Changes in Gini Coefficient in Japan Due to Income Redistribution



Note: Benefits in kind prior to 1999 were medical services only, while benefits in kind since 2002 include medical services, nursing care and childcare.
Source: Materials from the Ministry of Health, Labour and Welfare

poverty increased by 100 million between 1990 and 2005, with the poverty rate high at over 50%.

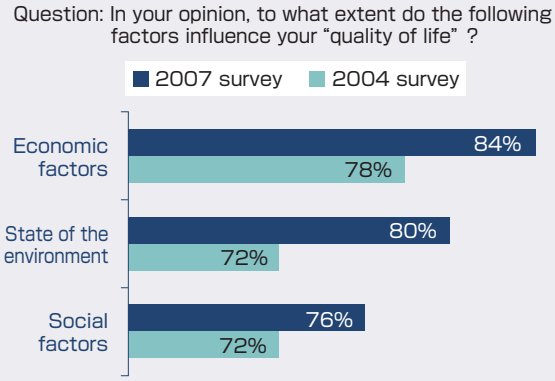
The United Nations estimates that as many as one billion people will remain in dire poverty even in 2015.

In advanced countries, the relative poverty, i.e. the income disparity, is an issue. The Gini coefficient is one of commonly used measures of inequality in income (the coefficient is shown in figures between 1 and 0, and the closer the figure is to 1, the larger the income disparity). The Gini coefficient has risen between the mid-1980s to the mid-2000s in 19 out of 24 member states of the Organization for Economic Cooperation and Development (OECD), indicating the increasing degree of inequality in many countries (Table Int.-2-4, Figure Int.-2-30).

Regarding the Gini coefficient in Japan, while initial income has been risen year by year, post-redistribution income has stayed flat since the 1999 survey (Figure Int.-2-31). According to a survey on the redistribution of income conducted by the Ministry of Health, Labour and Welfare in 2005, the Gini coefficient in 2005 stood at around 0.53 for initial income and around 0.39 for post-redistribution income. In recent years, the degree of improvement in the Gini coefficient by the redistribution of taxes and social security has grown larger by each survey, reaching a record 26.4% in the 2005 survey.

When the disparity in terms of income is widening, there is a view that the "quality of life" cannot necessarily be measured adequately by economic indicators such as income alone. According to the survey results released by the EU in 2008, while 84% of the survey respondents say that economic factors have a big impact on the "quality of life," as many as

Figure Int.-2-32 Survey Results Released by the EU in 2008 (Excerpts)



Note: The reply options to this question are "Very much," "Quite a lot," "Not much," "Not at all" and "DK (Don't know)." The numbers shown in the above figure are the sum of the percentages of responses "Very much" and "Quite a lot."

Source: European Commission, "Special Eurobarometer 295"

80% also say that environmental conditions affect the "quality of life" (Figure Int.-2-32). The EU survey results also show that over two-thirds of the respondents believe that social and environmental indicators should be equally used, along with economic indicators, to measure the degree of development of society. The European Commission reports that a similar survey carried out in 2007 by a private research firm in 10 countries on five continents found that an even larger ratio of 75% of respondents supported this idea.

Conclusion

In this section, we have examined several economic and social developments deeply related to environmental problems, ranging from population trends to the situation of poverty and income disparity.

Key points that have emerged from a variety of data are that consumption of resources and burdens on the environment have been increasing in tandem with population growth and expanding economic activities. Given global socioeconomic trends and the finite nature of natural resources, it is extremely difficult to sustain

the past patterns of economic and social activities featuring mass production, mass consumption and mass disposal. Higher demand for food associated with the population growth leads to higher demand for land and water resources, and the expansion of economic activities heightens energy needs and results in increased consumption of a host of resources. Also, the population growth particularly noticeable in developing countries accelerates the concentration of populations on cities, causing and aggravating a variety of environmental problems and leading to greater losses of biodiversity through development. Thus, it may be said that the process of advancement achieved by humankind in the past has not necessarily entailed adequate measures to conserve the natural environment.

Meanwhile, there is a growing awareness that the quality of life cannot be necessarily measured by economic aspects alone, and many people are coming to question the pursuit of endless development in disregard of the finitude of natural resources. In recent years, many national and local governments and various other entities around the world are making proactive efforts to fight global warming and conserve biodiversity. Many countries and international institutions are also seeking ways of economic development geared to the preservation of the environment, the idea called "green growth." As we reflect upon the past pattern of development and aspire for further development of mankind with full recognition of the importance of the environment, we are now witnessing an important paradigm shift in the history of mankind.

In the subsequent sections of this paper, we look at the present status of the environment in Japan in Chapter 1, and in Chapter 2 through Chapter 5, we examine how mankind is trying to achieve further development while preserving the environment and whether such development path is feasible, from the respective angles of global warming, biodiversity, water problems, and the environment and economy.

Column Observing Mankind for a Day from Outside the Earth…

We may say that mankind came into existence on the earth quite recently. In a matter of just several centuries, the human population has grown to 6.8 billion. Some 370,000 people are born and about 160,000 people die in a day, resulting in a net increase of about 220,000 in the population each day.

Mankind consumes about 150 km^3 of fresh water every day, and using the bulk of that water, is producing some 8 million tons of food a day. It is also true that a considerable part of the food produced is being discarded.

We produce some 3.7 million tons of crude steel a day. While we manufacture 200,000 new vehicles each day, we also scrap some 120,000 used vehicles each day. Individuals own cars even when they do not drive them very often, with the shift from the ownership value to the utility value apparently only beginning. We also produce some 1.08 million tons of paper every day.

It was only 200 years ago that mankind learned how to use energy for power. We only consumed one million barrels of crude oil a day 100 years ago, but we are now consuming 80 million barrels, an 80-fold jump. By consuming fossil fuels, we are producing 65 TWh of electric power a day and emitting 80 million tons-CO_2 of carbon dioxide in a single day.

We mine some 60 million tons of rocks a day, and are also consuming mineral resources. We are also discharging some 35 million tons of wastes per day, and some forecast that wastes are going to double over the next 50 years.

Humans have cut open rain forests and expanded farmland by burning down trees. Thus, it may be said that we have increased the number of individuals and prolonged the duration of life by depriving other living species of their habitats. In the course of human development, forest areas on the earth have been reduced to half, barren land has widened, and as many as 100 species are becoming extinct each day.

We need to fully recognize that nature takes 100 to 1,000 years to nurture 1 cm of land, that rich forests develop over several thousand years, that an astronomical length of time is required to form exhaustible mineral resources and bountiful ecosystems. We should refrain from the folly of using up the fruits of hundreds of millions of years in only a single day.

Thus far, mankind has been able to tide over a number of crises by the collective wisdom of the human race. But can we survive this environmental crisis in the same way?

Source : NASA Earth Observatory