Chapter 2
Background on Energy and Resources Strategy

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Abstract This chapter sets the scene for the series of lectures on energy and resources provided as part of the environmental leader course. Many of the individual lectures (chapters in this book) focus on specific resource or energy issues or technical challenges but these have also to be seen as part of an overall picture, where human activities have reached a scale which can no longer be supported in a sustainable way. This chapter provides some of the background to placing these individual fields in this wider perspective by looking at some of the history of environmental problems in Japan, as well as some key current international issues including global warming and climate change, social issues including poverty, threats to biodiversity and sustainability's limits and balances.

Keywords Environmental pollution · Energy · Resource · Limits · Sustainability · Japan

2.1 The Environmental Leader Programs

As described in Chap. 1, the thinking behind Japan's Environmental Leader programs is that even though many agree that we need to move rapidly to a more sustainable society, the current pace of change is failing to reverse adverse trends in energy and resources consumption, population growth, climate change, ecosystem loss, species extinctions and other key indicators of *un*sustainable development. This situation has led to initiatives in Japan to nurture a new generation of environmental leaders who can influence individual, business and governmental priorities and help promote the development of a more sustainable society. These programs face the challenges of providing participants with the knowledge, motivation and skills necessary to influence and lead others towards a more sustainable future.

The Environmental Leadership Training Program (ELTP) within the Strategic Energy and Resource Management and Sustainable Solutions (SERMSS 2014)

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Y. Tanaka et al. (eds.), *Topical Themes in Energy and Resources,*
DOI 10.1007/978-4-431-55309-0_2

(Tanaka 2014) project of the Graduate School of Environmental Sciences (GSES 2014) was outlined in Chap. 1 and has been designed to be flexible and allow students who are conducting research across a wide range of different disciplines (science, engineering and humanities) to participate in the same program. The ELTP comprises lectures to provide knowledge of sustainability and specific environmental problems and solutions, active learning to encourage personal skills development, fieldwork for practical experience and internships to provide intensive training opportunities- all built on the foundation of the student's basic scientific or engineering research. The ELTP was introduced in 2011 and over 110 students have already completed the various types of courses (Basic, Regular, Masters and Doctorate courses).

The ELTP teaching curriculum was shown in Table 1.3 and allows students to access teaching on international aspects, sustainability and environmental problems, problem solution identification and in leadership training. Features of Tohoku University ELP are that we have a foundation of global environmental issues, the energy/resources/water. One course, as outlined in Chap. 1, is a series of lectures related to strategy for energy and resources, and is provided by professors in the GSES on various aspects of energy and resources in their own research fields. In this chapter, I set out some general background considerations which are provided to course students to help them put each of the specialised lectures into the broader framework of sustainability's multiple dimensions. I also hope this can be a useful background to readers of this book.

2.2 Background Issues

2.2.1 Environmental Issues

The ELTP is motivated by our wish to help solve key global environmental problems. First of all, we must consider what are these problems? The following can be listed:

- Global warming.
- Deforestation.
- Depletion of the ozone layer (both North and South Poles).
- Acid rain (now including ocean acidification).
- Desertification.
- Artificial hazardous chemicals (also including diffusion and trans-border movements of hazardous chemicals and wastes).
- Exposure of the public to pollution in developing countries.
- Decreases in biodiversity.
- Marine pollution.
- Two historically local forms of pollution (referred in Japan to as KOGAI because of their effects on the public) have also spread to become important global environmental issues; air pollution, and water pollution/shortage.
- Increase in quantity and complexity of waste from human society.

Table 2.1 Main messages of the IPCC 2013 5th Assessment. (IPCC 2013)

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia
Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850
Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010
Over the last two decades, the Greenland and Antarctic ice sheets have been losing mass, glaciers have continued to shrink almost worldwide, and Arctic sea ice and Northern Hemisphere spring snow cover have continued to decrease in extent
The atmospheric concentrations of CO_2, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years. Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-Twentieth century
Global surface temperature change for the end of the Twenty-first century is *likely* to exceed 1.5 ºC relative to 1850–1900 for all RCP scenarios except RCP2.6. It is *likely* to exceed 2 ºC for RCP6.0 and RCP8.5, and *more likely than not* to exceed 2 ºC for RCP4.5. Warming will continue beyond 2100 under all RCP scenarios except RCP2.6. It is *very likely* that the Arctic sea ice cover will continue to shrink and thin and that Northern Hemisphere spring snow cover will decrease during the Twenty-first century as global mean surface temperature rises. Global glacier volume will further decrease
Global mean sea level will continue to rise during the Twenty-first century. Under all RCP scenarios the rate of sea level rise will *very likely* exceed that observed during 1971–2010 due to increased ocean warming and increased loss of mass from glaciers and ice sheets
Cumulative emissions of CO_2 largely determine global mean surface warming by the late Twenty-first century and beyond. Most aspects of climate change will persist for many centuries even if emissions of CO_2 are stopped. This represents a substantial multi-century climate change commitment created by past, present and future emissions of CO_2

Associated with each of these problems are some common factors; they all result from the rapid growth in human numbers and activity, in the rapid growth in the exploitation of resources, and the lack of any balance between consumption and its consequences. We have been attempting to deal with such pollution problems now for many years- particularly since the 1950s, and now know a lot about the environmental impacts of different types of emissions, how they spread and may or may not be degraded by the environment, how to measure and calculate toxic impacts, and how to mitigate the harmful effects of pollutants. Some of these major problems are under some degree of control (for instance the ozone layer depletion seems to have stabilised), but others such as deforestation, desertification and global warming show no signs of being placed under effective control. Only recently, the IPCC released the summary for policymakers in its 5th Assessment (IPCC 2013) which confirmed that global temperatures are rising as a result of emissions of greenhouse gases from human activities, that a further rise in temperature of up to 4.8 ºC can be expected by the end of the century (depending on the degree of success in reducing emissions), together with a sea level rise of 26–82 cm (Table 2.1). A critical fact

Table 2.2 History of some major pollution events in Japan

1890: Ashio Copper Mine—Furukawa Co., Ltd
1937: Annaka public pollution lawsuit—Toho Zinc Co., Ltd
1910: "Itai-itai disease", caused by cadmium poisoning from industrial wastes in Toyama Prefecture—Mitsui Mining and Smelting Co. (successful lawsuit)
1956: Minamata disease (poisoning caused by industrial mercury pollution). Chisso Co. (successful lawsuit)
1958: Edogawa Fishing industry damage—Honshu Paper Co., Ltd. (Oji Paper Co., Ltd.) led to the Water Pollution Prevention Act
1960: Yokkaichi asthma—Caused by many companies: Yokkaichi Petrochemical Complex (successful lawsuit)
1965: Niigata Minamata disease—Showa Denko K.K. (successful lawsuit)
1968: PCB Kanemi rice oil disease incident
1970: First appearance of Tokyo photochemical smog
1970s: dust pollution due to studded tires; 1988: discontinued production and sale
Thalidomide baby lawsuit for drug-induced physical deformations, Smon (subacute myelo-optic neuropathy) disease medication scandals

The importance of legal action to combat major cases of pollution is shown in **bold**

which IPCC pointed out is that the level of warming is determined by the overall quantity of carbon dioxide in the atmosphere, and that to have a 2/3 chance of limiting warming to 2 ºC, the total emission since industrial revolution need to be limited to 1000 Gt carbon; *half of this* has already been used and at current rates, the rest will be emitted in the next 20 or so years. The largest causes of this global warming are human activity and excess energy consumption. For energy, see the described outline in 1.3.1. of Chap. 1.

2.2.2 Japan's History

Looking at Japan, the legal framework for dealing with pollution is influenced very much by our own country's historical experience of gross public pollution. The country's rapid economic growth during the 1950s and the complete lack of any environmental controls with the priority firmly on the economy, led to many local cases of dead rivers, gross levels of air pollution and also several toxic events including mercury poisoning at Minamata and Niigata, and food contamination by PCBs and cadmium. This history of events means that under Section 3, Article 2 in the Japanese Basic Environment Law, the main examples of environmental pollution and destruction include atmospheric pollution, water pollution, soil pollution, noise, vibration, odours and unpleasant smells, and land subsidence. We might also since add light pollution, obstruction of sunshine by buildings, dioxins, asbestos, hormone disrupting chemicals, hazardous chemicals, chemical allergies, cedar pollution allergies, and others. Some of the major influences on government legislation are listed in Table 2.2.

Table 2.3 Famous pollution incidents outside Japan and influential books or movies

Incidents
London Great Smog of 1952
Muse Valley incident of 1930
Los Angeles smog of 1945
Dorano pollution incident of 1948
Love Canal incident of 1978: enactment of laws for a Superfund
Environmental problems in developing countries such as Peking smogs
Books and movies with great impact
Rachel Louise Carson, "Silent Spring" 1962
Tomoyuki Tanaka produces "Godzilla vs. Monster of Chemical Ooze" 1971
Theo Colborn, John Peterson Myers, Dianne Dumanoski, "Our Stolen Future" 1996
Deborah Cadbury, "The Feminization of Nature" 1997
"Erin Brockovich" movie 2000
"The Day After Tomorrow" movie 2004
Al Gore, Jr., "An Inconvenient Truth" 2006

As can be seen from Table 2.2, Japan's history of pollution events goes back many years—even to the nineteenth century and the first involvement of politicians in trying to solve a public pollution problem. This was well before the days of parliaments and laws, and in one example in the 1890s, Shozo Tanaka had to make a direct appeal to the Meiji Emperor to take action against the Ashio copper mine's environmental damage to local citizens, farming, and forests. Perhaps this might be categorized as an early example of an environmental leader!

Of course Japan's experience is not unique and has been mirrored across the world; many similarly famous incidents in other countries have led to new laws and regulations to try and overcome the basic problem of environmental pollution (Table 2.3). Some environmental issues have truly entered the public consciousness through books such as Rachel Carson's "Silent Spring", books on hormone disrupting chemicals ("Our Stolen Future" and "Feminisation of Nature"), and of course Al Gore's "An Inconvenient Truth" on global warming.

In Japan, the gross impacts of pollution even entered the public consciousness through famous monster characters such as Godzilla! In the 1971 movie "Godzilla versus the Monster of Chemical Ooze", the monster Hedorah (Fig. 2.1) was able to feed on pollution. In this way a pollution event in real life (Hedorah is the name for a waste sludge from paper production at Tagono-Ura, Shizuoka Prefecture) causing local social problems, became a theme and message reaching children around the world.

In tackling pollution problems, a contrast is often drawn between developed and developing countries. We can summarise the different influences and interactions between developed and developing countries and environmental issues in Fig. 2.2. This shows that some of the central environmental issues may appear at first sight

Fig. 2.1 Pollution in movies-the Story of "Godzilla vs. Hedorah"(1971 Toho Co., Ltd.)

to be more closely linked to one type of country; but in fact whether developed or developing countries, all are contributing to the problems and also must contribute to their solution.

2.2.3 The Overall Challenges

Let us now turn to the central part of this course where we try and answer the questions:

- What is the basic nature of environmental problems?
- What is their cause?
- How do we correct them?

First let us have a brief look at the second half of the twentieth century-Table 2.4 summarises the growth which has occurred between 1950 and 2000 in a range of indicators of human activity. Since 1950, global population has tripled, energy consumption has increased 15 times and global GNP increased about 21 times. During this period the environmental problems mentioned above have also worsened, requiring substantial expansions in environmental laws and regulations in the last 50 years in order to deal with the more urgent problems (Meadows (1999), Meadows et al. (2004). It is an understatement to say that the twentieth century was a century of rapidly expanding

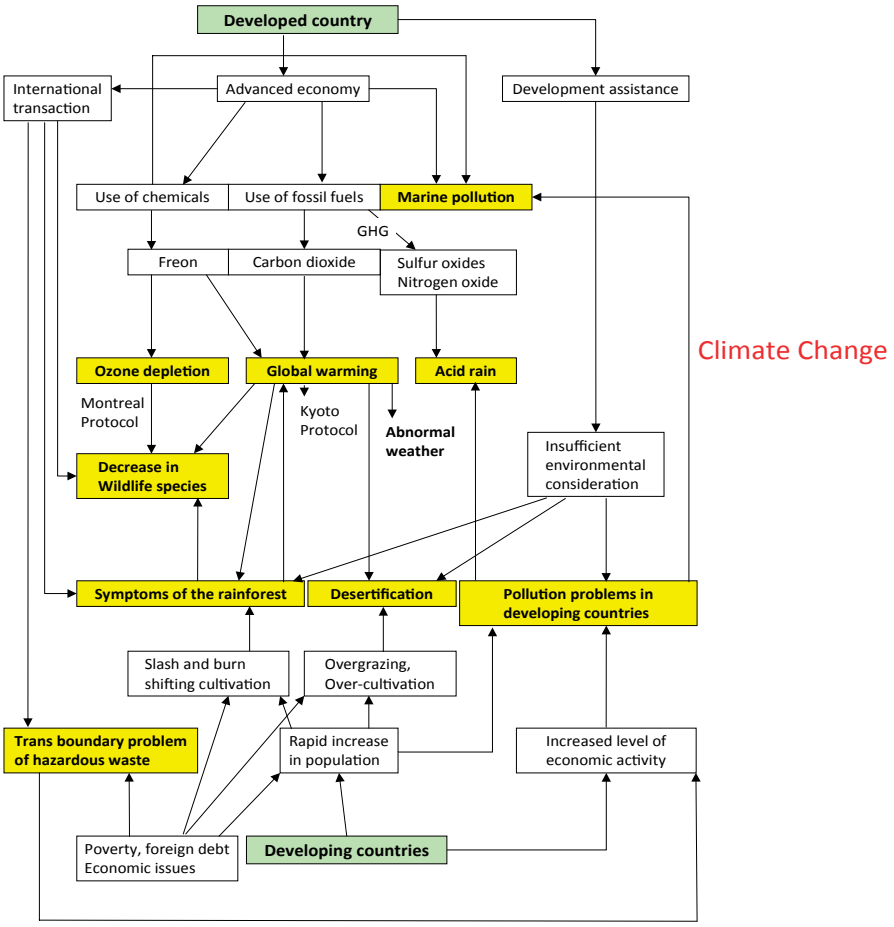

Fig. 2.2 Different origins and responses to environmental problems in developed and developing countries. (Source: Guide for Global Environmental Research Committee, edited by keywords related to the environment)

human activity[1]. The key six elements of energy, resources, chemicals, water, food, and atmosphere are all under stress as a result of growth in population and human activities. Driving all these is an apparently insatiable appetite of humankind in both numbers (population growth) and consumption (energy and resources). I see this 'human desire' as driving all these global trends. For example, the ecological footprint says current human activities have already greatly exceeded the capacity of our one Earth. In view of the state of the planet beyond the sustainability the

[1] The next chapter (3) describes the consequences of continued growth and the limits to growth from environmental pollution and consumption of resources modeled by Meadows (1999), Meadows et al. (2004).

Table 2.4 Growth in the second half of the twentieth century

	1950	Changes 1950–1975 (%)	1975	Changes 1950–2000 (%)	2000
World population (100 million)	25.2	160	40.8	247	60.7
Registered vehicles (millions)	70	470	328	1030	723
Petroleum (million barrels)	3800	540	20,512	727	27,635
Natural gas (trillion cubic feet)	6.5	680	44.4	1454	94.5
Coal (million tons)	1400	230	3,300	364	5100
Generation capacity (million kW)	154	1040	1,606	2104	3240
Maize production (million tons)	131	260	342	453	594
Timber production (million tons)	12	830	102	1425	171
Steel production (million tons)	134	350	468	455	580

current situation, Dr. Meadows (et al.) pointed out that the global economy will approach its limits by environmental pollution and consumption of resources, in "The Limits to Growth" which was published in 1972. (D. H. Meadows, 1972). They also published "The Limits to Growth: a 30-Year Update" in 2004. They speculated on multiple scenarios around the world from an environmental stance which is increasingly worse through "desire" and "overkill" by humankind. (D. H. Meadows, 2004) In his report in 2009, Dr. Rockstrom also pointed out how some human activities have already exceeded their limits.

Such high rates of consumption may lead to resource shortages as described in the next chapter by Professor Taniguchi. But it has also exceeded the ability of the planet to provide a range of ecosystem services and natural resources on a sustainable basis (see environmental management tools in the next chapter), while at the same time actually making some of the economic indicators of sustainability worse-as evidenced by the widening gap between the rich and poor (Fig. 2.3). Indeed the widening inequality only serves to exacerbate poverty. In turn, poverty is not only one of the biggest problems in our society, but it is also has a deep relationship with

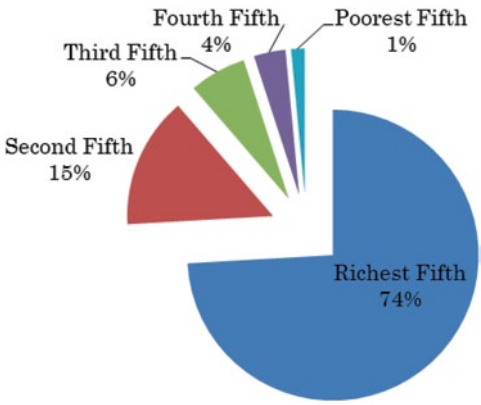

Fig. 2.3 World income distribution (Source: Data from Dikhanov, Y. (2005). Trends in global income distribution, 1970–2000, and scenarios for 2015. New York, NY: United Nations Development Programme.)

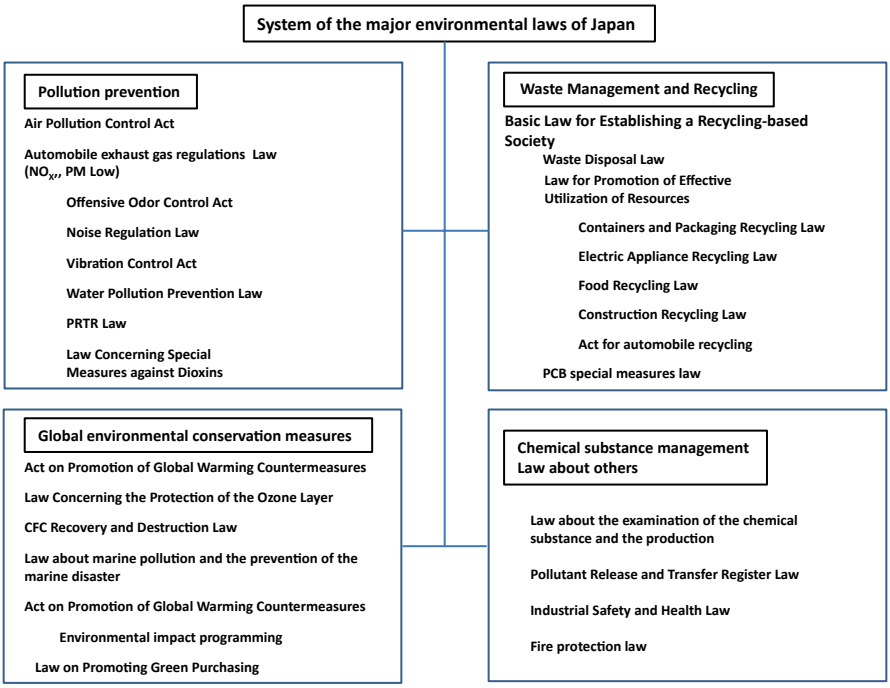

Fig. 2.4 Japan's legal framework for the Environment and Recycling Society. (Translated from http://www.logistics.or.jp/green/map.html. Accessed 26 June 2014)

environmental issues such as deforestation, expansion of desertification, and environmental issues in developing countries. As recognised in the original Brundtland report (WCED 1987), when there is no food today, who will think about the future? When there is no firewood today, who will protect the forest of tomorrow? At present, the 2 % richest monopolize more than 50 % of world income. In contrast, the poorest 20 % of people only have 1–2 % of global income.

What has been happening in businesses and companies during this period? There have certainly been changes in corporate environmental management, starting with the growth in environmental reporting in the 1980s and 1990s and the first international environmental standard (ISO 14001) from 1996. In recent years, the term 'Eco' has become widespread (eco-points, eco-car, etc.) together with advances in energy-saving appliances, technological advances in energy conservation and pollution control technology, and other contributions to reducing environment impact. A comprehensive range of laws has emerged on various public nuisances and also one of the world's leading legal frameworks for a 'recycle based society' has emerged in Japan (see Fig. 2.4). Japan is not alone in this and the EU has also introduced a range of environmental directives on *W*aste *E*lectrical and *E*lectronic *E*quipment (WEEE directive), the use of certain hazardous substances in electrical and electronic equipment (RoHS: *R*estriction *o*f *H*azardous *S*ubstances) and the regulation on *R*egistration, *E*valuation *A*uthorisation and *R*estriction of *CH*emicals (REACH).

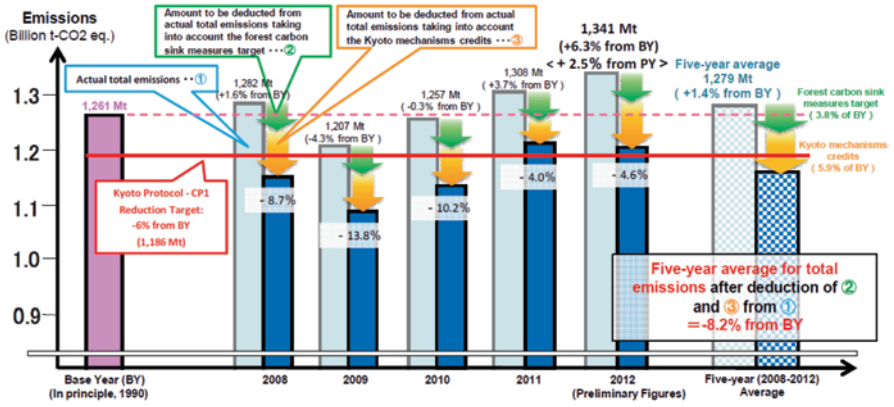

Fig. 2.5 Japan's CO_2 emissions to 2012. (Source: Ministry of the Environment; http://www.env.go.jp/en/headline/file_view.php?serial=547&hou_id=2031. Accessed 26 June 2014)

Despite these positive trends however, when the overall scale of environmental impact is measured in terms of CO_2 emissions, Japan along with other countries, has still made little progress. Japan agreed to reduce total emissions under the Kyoto protocol by 6% relative to 1990. By 2009, Japan's emissions had declined slightly, but the switch from nuclear power to fossil fuels following the 2011 Fukushima nuclear disaster reversed this, and Japan has shown the largest increase in CO_2 emissions of any of developed country in the last year, with a rise in emissions of 4% in 2011 and a further rise of 2.7% in 2012 (Fig. 2.5). Nevertheless with the help of absorption of CO_2 through forest carbon sinks, and purchases of carbon credits through the Kyoto mechanisms, Japan was at least one of the original Annex 1 countries who did meet their original commitment (in contrast to countries such as USA which did not join the Protocol and Canada which reneged on its original commitments). However the Abe government announced in November 2013 that it would abandon the further reduction target of 25% by 2020 adopted by the previous government. Instead, it adopted a target of an *increase* (of 3–4%) relative to the 1990 baseline.

The effects of the 2011 disaster on household energy can be seen in Fig. 2.6. Emissions of CO_2 from the average household in Japan were 4758 kg in fiscal 2010. Supply of electricity was interrupted by the earthquake and following this, nuclear power generation was stopped due to local opposition to restarts after routine maintenance and due to increased regulatory standards and approval procedures. As a result, the supply of electricity has shifted from nuclear generation to fossil fuel-using thermal power generation. Despite many additional measures for saving energy, CO_2 emissions rose to 5060 kg/household in fiscal 2011. This is an increase of about 300 [$kgCO_2$/ household], or about 6% (Fig. 2.6). And this is 5,270kg/household in FY 2012. Basically, the average Japanese household is emitting higher levels of CO_2 because of the loss of CO_2 emission-free nuclear power from the electricity supply side. However, at present we cannot pronounce the reactivation of nuclear power plants as something "good or bad." This is because the cause of accident of Fukushima nuclear plant is not yet clear and no one can guarantee the safety of nuclear

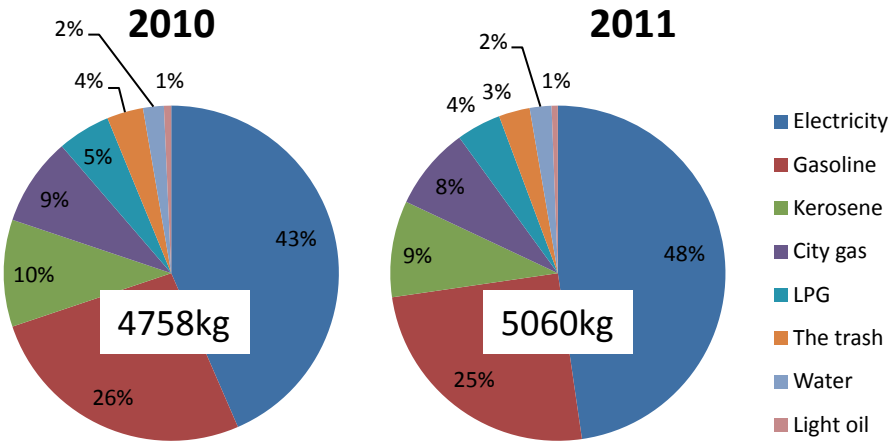

Fig. 2.6 Household emissions before and after the 2011 Disaster. (Source: Japan GHG Inventory Office; https://www.env.go.jp/policy/hakusyo/h25/html/hj13020201.html. Accessed 26 June 2014)

Table 2.5 CO_2 emissions by country ranking trends—2012 (million tons). (Data from Netherlands Environment Assessment Agency)

1.	China 9860
2.	United States 5190
3.	India 1970
4.	Russian Federation 1770
5.	*Japan 1320*
6.	Germany 810
7.	Korea Rep. 640
8.	Canada 560
9.	United Kingdom 490
10.	Mexico 490
11.	Indonesia 490
12.	Saudi Arabia 460
13.	Brazil 460
14.	Australia 430
15.	Iran Islamic Rep. 410
16.	Italy 390

power generation at the moment. Furthermore, we have not resolved the treatment methods to dispose of highly radioactive either technologically or socially.

The growth in emissions from other countries however means that Japan remains in fifth position in the amount of CO_2 emitted (Table 2.5). These global emissions continue to increase the CO_2 concentration in the atmosphere, which passed 400 ppm in 2013—a level not reached for almost 1 million years.

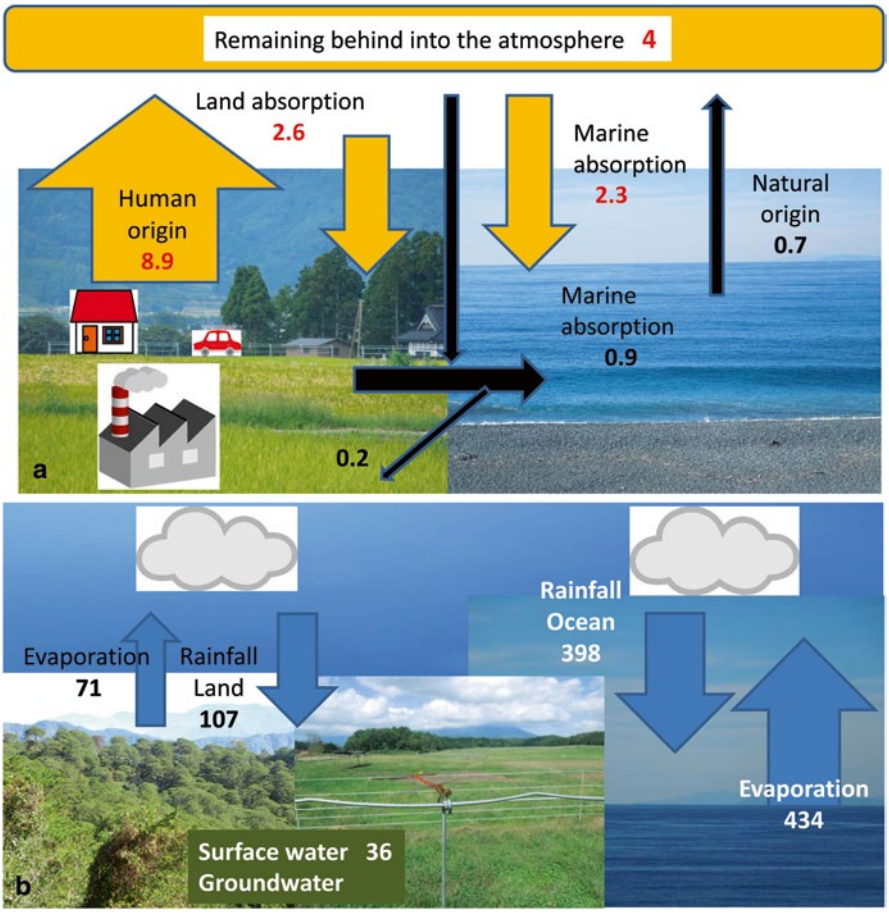

Fig. 2.7 Natural cycles being disturbed by humanactivities–carbon cycle, water cycle, atmosphere circulation, ocean circulation. **a** Schematic diagram of anthropogenic carbon balance (Unit: Giga ton) Yellow: Amount by industrial activity Black: Before Industrial Revolution (Source: Adapted from Japan Meteorological Agency: http://www.data.jma.go.jp/kaiyou/db/mar_env/knowledge/global_co2_flux/carbon_cycle. **b** 2.7.2 Average Movement of water peryear [×103km3/y] (Note: By the law of conservation of mass) (Source: Adapted from JGL, Vol. 3, No.3 2007. Oki and Kanae (2006) revised)

2.2.4 Sustainability, Limits and Balances

Moving to the broader system aspects of sustainability, increasingly we must think of the earth as a dynamic system under increasingly severe disturbance from human activity. Whether it is the carbon cycle, the water cycle, the climate system or the ocean circulation system, human activities are now on a scale capable of disrupting these essential systematic life-support systems for humankind (Fig. 2.7 illustrates carbon and water cycles). Hollywood movies enjoy dramatising future catastrophes arising from our planetary limits being exceeded, but the science is telling us that this is not science fiction- the future life-support system for humankind really are in

jeopardy. Rockstrom et al.'s paper in Nature in 2009 starts to quantify this and identifies essential limits which together provide a "Safe operating space for Humanity". Sustainability basically signifies that we have to keep and maintain a safe and satisfactory life for our descendants, and thus **balance** is becoming an important key word. For example, the balance between the earth's capacity and human activity, the balance between nature and human, between living creatures and humans, between the environment and the economy, between hope and desire. It may be necessary to suppress our own numbers or activities to maintain these critical balances. Indeed, I believe that it is increasingly necessary to establish a balance between the earth and human activity in order to maintain the sustainability of both nature and humanity. This in turn requires us to be better in our selection of which technology to use, to limit the appetite (greed) in our mind and to also care about other people. It is necessary to ask a number of key questions if we are to consider true happiness in a sustainable world. "What is our happiness and satisfaction?" "Which is more important, philosophical satisfaction and family especially children and grandchildren, or materials/money/power?" "What is our true purpose?"

2.2.5 Biodiversity

In this short introduction, we also need to point to the drastic reduction in planetary biodiversity which is underway. This is not necessarily a pollution issue but really a symptom of how the increasing population of the planet needs yet more and more land to provide the resources needed for food, timber, fish and other biological resources. I can just point to the explosive growth in the coverage of Southeast Asia (Malaysian and Indonesia in particular) in producing Palm oil (see Fig. 2.8). The destruction of the forest to replace with palm oil plantation is one of the biggest causes of biodiversity loss, and also periodically leads to extremely poor air quality in the region, as well as destroying the hitherto sustainable forest-based life styles of

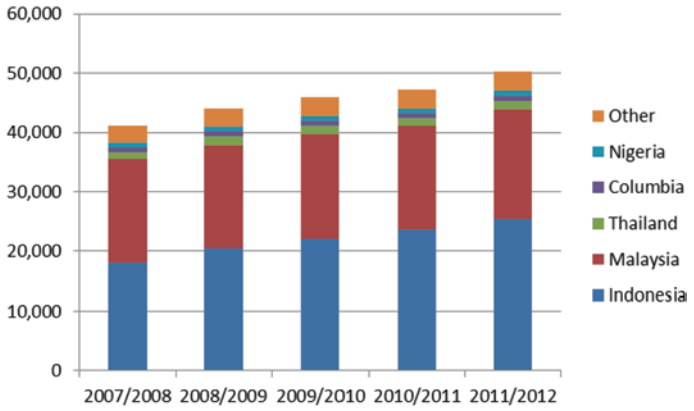

Fig. 2.8 Palm oil production trends. (USDA data). (Unit: 1000 tons)(Source:USDA "World Markets and Trade"August-July)

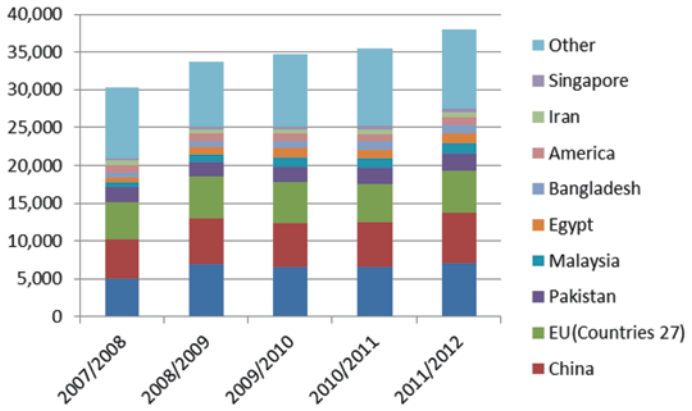

Fig. 2.9 World imports of palm oil. (USDA data). (Unit: 1000 tons) (Source: USDA"World Markets and Trade"August-July)

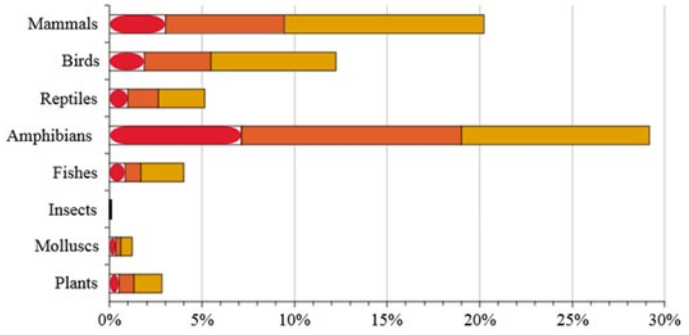

Fig. 2.10 Threatened species of the world. (IUCN 2007 data from http://en.wikipedia.org/wiki/File:IUCN_Red_List_2007.svg. Accessed 26 June 2014)

indigenous people. The driving forces here are not just in the producing countries—as can be seen from Fig. 2.9, the real driving force is the demand in the importing countries such as China, EU, Pakistan, Egypt, and so on.

Biodiversity and the associated ecosystem services are becoming important issues for global sustainability. For a sustainable world, maintaining biodiversity is recognised as very important. In fact, we humans do not even know how many creatures inhabit the earth. Currently, it is said that about 1.4–1.8 million species are recognized scientifically, but some scholars say the numbers of species, including yet unknown organisms, may be much greater. Scientists are now warning that 0.1–0.01 % are becoming extinct every year. The biggest contribution to the accelerating modern rates of extinction (loss of biological diversity) is human activity- especially loss of habitat through habitat destruction or land use change. The Millennium Ecosystem Assessment (MEA 2005) said that the rate of extinction of species is 1000–10,000 times that which would occur in the absence of human involvement, and numbers of threatened species globally are shown in Fig. 2.10. Natural ecosystems exist in complex and subtle balances, which if destroyed may

Mammals	Japanese wolf
	Ezo wolf
	Japanese sea lion
	Okinawa flying fox
	Bonin pipistrelle
Birds	Rufous night heron (Ogasawara island subspecies)
	Crested shelduck
	White-browed crake (Iwo islands sub-species)
	Ryukyu wood pigeon
	Bonin wood pigeon
	Miyako kingfisher
	White-bellied black woodpecker
	Wren(Daito island subspecies)
	Bonin island thrush
	Borodino bush warbler
	Varied tit(Daito islands subspecies)
	Bonin islands honeyeater (Mukoshima islands subspecies)
	Bonin islands grosbeak

Fig. 2.11 Japanese mammals and birds already extinct and those currently endangered. (MOE http://www.env.go.jp/en/nature/biodiv/reddata.html. Accessed 26 June 2014)

not be capable of being restored through human intervention. Biodiversity loss involving the extinction of many organisms raises ethical questions and the question of whether it is any different to allowing the extinction of humans. Japan has its own list of species already extinct and those endangered as in Fig. 2.11. It is important to emphasise that current rates of species extinction have occurred in the past only as a result of catastrophic events such as volcanoes, asteroid impacts, but now are due to human activity.

2.2.6 Energy, Water, Food and its Security

There are two sides to many of the major challenges facing a sustainable world. For instance, with energy there is the environmental impact- the increase in carbon dioxide and harmful substances due to the use of fossil fuels (problems of air pollution and global warming). On the other hand, there are concerns over depletion of energy in general and the specific problem of energy security in Japan. In the latter case, the energy self-sufficiency rate in Japan is about 20%, even when there is nuclear power. If there is no nuclear power, self-sufficiency is about 4% or lower. It is thus important to increase renewable energy usage substantially as soon as possible. We will explain one of the examples of such a new energy system in a later chapter (Chap. 7).

Fig. 2.11 continued

Mammals	Japanese river otter
	Tsushima cat
	Iriomote cat
Birds	Short-tailed albatross
	Red-faced cormorant
	White stork(East Asiatic subspecies)
	Japanese crested ibis
	White-tailed sea-eagle
	Buzzard(Ogasawara islands subspecies)
	Buzzard(Daito islands subspecies)
	Hodgson's hawk eagle(Japanese sub-species)
	Golden eagle(Japanese subspecies)
	Crested serpent eagle(Ryukyu islands subspecies)
	Ptarmigan(Japanese subspecies)
	Japanese crane(Red-crowned crane)
	Okinawa rail
	Amami woodcock
	Guillemot, Common murre(Japanese sub-species)
	Tufted puffin
	Japanese wood pigeon(Yaeyama islands subspecies)
	Japanese wood pigeon(Ogasawara and Iwo islands subspecies)
	Emerald dove (Ryukyu islands subspecies)
	Blakiston's fish owl(Japanese sub-species)
	Pryer's woodpecker
	White-backed woodpecker(Amami-oshimasubuspecies)
	Three-toed woodpecker(Japanese sub-species)
	Fairy pitta(East Asiatic subspecies)
	White's ground thrush(Amami-oshima subspecies)
	Bonin islands honeyeater(Hahajima islands subspecies)
	Oriental greenfinch(Ogasawara and Iwo island subspecies)

Water pollution is a serious issue in many areas, but water supply is an even more important issue than energy in many parts of the world. The water which humanity can use easily is about 0.01–0.02 % of the water on the planet—the freshwater existing in the rivers and lakes, and stored in glaciers and underground aquifers (Fig. 2.12). According to the UNDP (United Nations Development Programme), one in five developing countries' population (about 1.1 billion people) cannot be assured of the water needed for farming. These water shortages become more severe with population growth. Currently 884 million people do not have access to 'safe' drinking water in the world. The water environment is thus threatened not just in quality but also quantity.

Food is also an important issue. Malnourished people in the world now are estimated at 925 million, of which 563 million (corresponding to two thirds) are living in the Asia-Pacific Ocean region. The food self-sufficiency rate in Japan has fallen to 40 % in a calorie basis. Since the environment for food production may worsen due to global warming, the countries that are not able to be self-sufficient in food and the associated risks of food shortages are growing. These problems have to be considered in parallel with environmental issues.

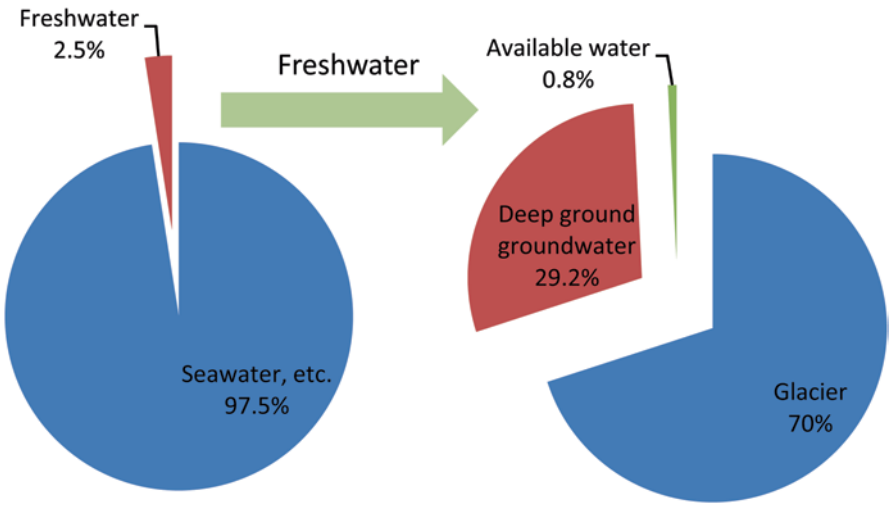

Fig. 2.12 Water available for human use. (Source: UNEP and Japan Water Guard) http://npo-jwg.com/studypl.html

Table 2.6 Three principles of Herman E. Daly

Use rate of renewable resources should not exceed the rate of renewal
Use rate of non-renewable resources should not exceed the speed of conversion to renewable resources
The emission rate of pollutants may not exceed the speed or absorption or degradation in the environment

Table 2.7 Four principles for sustainable development

Concentrations of matter extracted from the Earth should not increase
Chemicals produced by Society should not increase in nature
Nature should not be weakened by physical processes
Society must not create obstacles which deny people the opportunity to meet their needs

2.2.7 Guidelines to Achieving Sustainability

Looking for guidelines to maintain sustainability, three principles were proposed by Herman Daly in 1972, and four Natural Step rules were also proposed by Karl Heinrike Robert in 1989. These are summarized in Tables 2.6 and 2.7 respectively.

I translate these in a more personal way as in Table 2.8, and link them to the fundamental human motives, actions and consequences in Fig. 2.13.

This is what I believe to be necessary to resolve current global environmental problems. To do this, we need the power of young people like the "Environmental Leaders" we are attempting to train in the Environmental Leader program.

Table 2.8 Guidelines made on behalf of the resolution of global environmental problems and sustainable society

Resources that are currently thought not to be depleted should be used in a manner which does not disturb that balance
Resources that are being depleted; we should establish alternative sources or ways of avoiding their use *before* the resource is lost
In the areas of the earth we must use, we do so without destroying the balance. Should not discharge wastes above the limit of natural degradative processes and avoid discharging those that do not decompose naturally
The objective should be personal happiness in peace and fairness

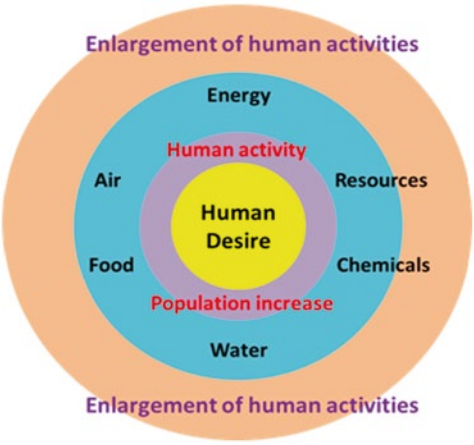

Fig. 2.13 Environmental issues and their root causes

In summary, I have pointed out that global environmental issues of today are occurring as a result of human activities which are beyond the tolerance of the earth. The reasons for this include the trends shown in Fig. 2.13:

1. Overpopulation by explosive population growth.
2. Excessive use of energy, resources chemicals, and water through the growth in human activities.
3. Diffusion of chemicals and increase of waste beyond levels that can be handled.
4. Changes which humans are causing are too fast.
5. In other words, people have caused radical changes in both quality and quantity over a very short period of time (almost instantly in terms of Earth's geological history).

In this series of lectures I ask the students to ask the following questions, and do the same to the readers of this book.

1. What is the essence of environmental issues?
2. What is the cause of environmental problems?
3. How do you solve these problems? What are our best actions?

These are just some of the issues that will be addressed in more detailed during the rest of this course and which are the focus of later chapters in this book.

A Postscript

While this course on energy and resources strategy was being given (October 2013–March 2014), there were many abnormal weather phenomena around the world such as the heavy rain on the Indochina Peninsula in September 2013, Typhoon No. 30 (HAIYAN) in the Philippines in November 2013, and extremely cold weather in North America from December 2013 to January 2014. Furthermore, PM 2.5 warnings (air pollution) have been issued in various regions because of air pollution blowing from China to Japan, resulting in days when children are forbidden to play outside in the Kyushu and Kansai Regions in Japan. In Paris, the atmosphere has become contaminated by exhaust gases, and the Eiffel Tower appears hazy in the smog. In response, car use has been limited to even or odd-numbered days according to license plate numbers.

This reminds us that pollution is not a problem of only one country or region. It exists on a global scale with cross-border pollution from country to country. Water pollution, desertification, and other severe, pressing issues are also continuing. According to the latest information, the average temperature of the world in 2014 was 0.27℃ over that of an average year. In other words, the average temperature of the world in 2014 will have been the highest since the start of statistical records in 1891. It is thus important for Japan to consider how it can contribute to the world through new technology in such fields as introducing renewable energy, energy saving, the prevention of air/water pollution and their purification—especially for developing countries in Asia, Africa, and South and Central America.

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