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WHAT SHOULD WE DO TO IMPROVE THE FUTURE FOR HUMANS?

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Abstract

Numerous problems have been predicted as an outcome of an increasing global population, including water shortages, food crises, resource depletion, and global warming, with the world population predicted to reach 9~10 billion by the 22nd century. Stabilizing populations relatively quickly would be beneficial, and could be achieved by financially supporting developing countries to promote the education of women, which would help decrease birth rates. In addition, a two-child policy would be highly effective if it were adopted by the United Nations. Water shortages are already a serious issue and population stabilization should be accelerated to minimize further shortages. Conversely, the world food stock is sufficient to support the global population, so food crises are political problems that will not increase in severity after population stabilization. In addition, energy resources could support a stabilized population for at least for the next 153 years if unconventional fossil fuels are used. Moreover, there is sufficient thorium to supply all primary energy for 58 years, while sea uranium could provide energy for 1,000 years if used in light-water reactors or for two billion years if used in fast breeder reactors. Nuclear waste will be disposed of into the Sun via space elevators within 50 years. The progression of global warming is decelerating in the 21st century, probably due to inactivity of the sun, and mitigating global warming will not be necessary if the sun remains inactive. Even if solar activity increases, reducing CO_2 by 50% would only mitigate global warming by 0.7 K by 2050 and cause huge economic losses. Instead, we should focus on developing techniques to prevent devastating earthquakes, catastrophic volcanic eruptions, and giant meteorite impacts.

Keywords: Devastating Earthquakes, Catastrophic Eruptions, Giant Meteorite Impacts, Global Warming, Population Stabilization

Introduction

First, potential future problems for human society were specified and relationships between some of the problems were investigated. Population increase was found to be the cause of the selected problems and countermeasures were considered. It was found that the remaining potential problems would not be serious if the human population could be stabilized, relatively soon, at 9~10 billion. Devastating disasters such as giant earthquakes, large-scale earthquakes underneath big cities, catastrophic volcanic eruptions, and giant meteorite impacts were then considered and countermeasures were proposed. Finally, in the concluding remarks, the author summarizes what we should do to improve the future for humans.

Various Potential Problems

There are potentially many future problems for human society (Table 1). With regard to environmental problems, organizations such as the Intergovernmental Panel on Climate Change (IPCC) and the Japan Broadcasting Corporation (NHK) have suggested that we should reduce anthropogenic CO_2 emissions to mitigate global warming. In contrast, some other studies have raised concerns about immediate global cooling. The Earth's surface was severely contaminated by above-ground nuclear weapons testing and is still being contaminated by radioactive nuclides from the collapsed Fukushima nuclear power plant. More than seven million people died globally in 2013 due to PM2.5 exposure (source: World Health Organization (WHO)).

The increase in human population is causing many other social problems. A significant number of people are starving worldwide, whereas many people in developed countries are suffering from obesity and dispose of considerable amounts of food every day. Some researchers have speculated that petroleum resources will be exhausted in 50 years.

With regard to political and economic problems, the world economy has been recovering from the Lehman shock in 2008. However, it is still unstable and is currently suffering from other issues, such as the Greek Crisis, a setback in the growth of the Chinese economy, and the currency crisis in Brazil. Poverty can be regarded as the main cause of social problems. Religious wars have occurred and are likely to continue to be experienced. In the United States (US), President Obama declared an intention to reduce nuclear weapons and subsequently received the Nobel Peace Prize but, ultimately, he was not able to reduce their number.

Table 1. Examples of potential future problems for human society.

- Environmental problems
  - Global warming
  - Global cooling
  - Radioactive contamination
    - Atmospheric nuclear explosions
    - Nuclear power plant accidents
  - PM2.5
    - More than 7 million people died in 2013 (WHO)
- Social problems
  - Population increase
  - Food crises
  - Depletion of energy, mineral and water resources
- Political and economic problems
  - Economic crises
  - Poverty
  - Religious wars
  - Nuclear wars
- Epidemics
  - Ebola hemorrhagic fever
  - HIV (50 million infected people)
  - Malaria (1-1.5 million death/year)
- Devastating disasters
  - Giant earthquakes and tsunami
  - Catastrophic eruptions
  - Meteorite impaction

The recent Ebola hemorrhagic fever outbreak in western Africa seems to have ended. However, human immunodeficiency virus (HIV) is still prevalent and 50 million people worldwide are infected. Malaria is also killing 1~1.5 million people per year because developed countries have prohibited the use of dichloro-diphenyl-trichloroethane (DDT) after malaria was almost eradicated in the developed countries. Human societies are also affected by such devastating disasters as giant earthquakes and tsunamis, large-scale earthquakes underneath big cities, catastrophic volcanic eruptions, and giant meteorite impacts.

As an initial step in considering what we should do to improve the future for human society, some of these problems were selected (Fig. 1). They are closely related to each other. For example, water shortages will accelerate food crises, but food crises will subsequently decelerate population increases. The depletion of energy resources will accelerate food crises because petroleum is required to cultivate fields, sow seeds, make and apply pesticides, and harvest and transport products. Nitrogen type-fertilizers are made with natural gas, hot water vapor, and atmospheric nitrogen in the Haber-Bosch process. Approximately half of the nitrogen in our body originates from factory made-fertilizers. The problem of global warming will automatically be solved if fossil energy resources are exhausted. According to the IPCC, water shortages will be accelerated by global warming because precipitation will increase in some areas, but the increased rainwater will flow as mud water during floods.

Food crises will be decelerated by a global warming of 2~3 K, because food production is predicted to increase (IPCC). The blue arrow with a question mark in Figure 1 indicates that global warming will decelerate population increases because it is projected that the frequency of extreme weather events will increase. However, this claim is suspicious. For example, neither the number (Fig. 2) nor intensity of typhoons in the Pacific Ocean is currently increasing.

It is apparent that population increases accelerate water shortages, food crises, and the depletion of energy and mineral resources. Global warming will also be accelerated if anthropogenic CO_2 emissions are the cause of it. From the above discussions, it can be clearly seen that the increase in the global human population is the cause of these problems.

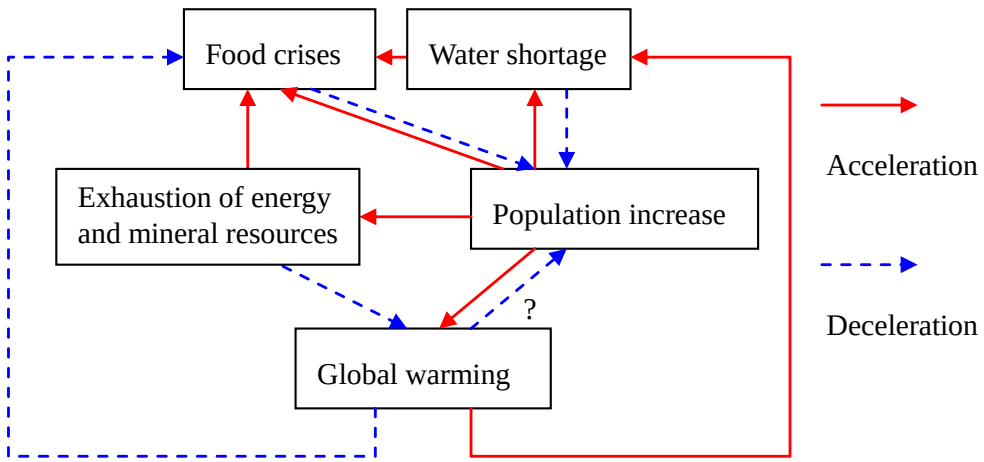

Figure 1. Relationships between selected global problems facing human society.

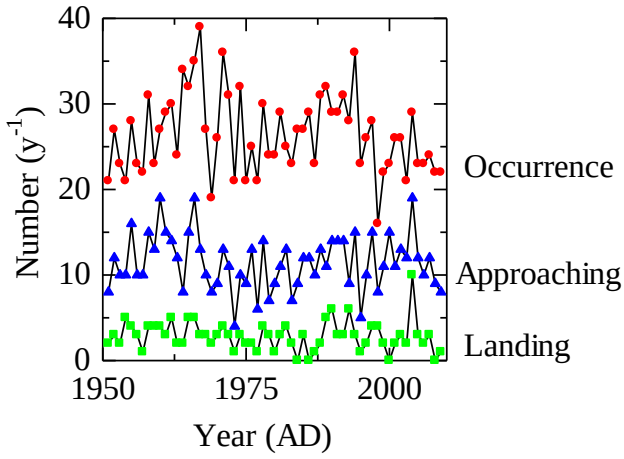

Figure 2. Number of Pacific Ocean typhoons that have occurred, approached, or landed in Japan (source: Japan Meteorological Agency (JMA)).

Population Stabilization

Population in developed countries has almost stabilized (Fig. 3), although the Japanese population is decreasing. The death rate decreases and nutrition and medical services improve as a country becomes wealthier. Birth rates decrease with mechanization in agriculture, the establishment of pension systems, increases in education costs, and increases in the availability of jobs for women. However, the decrease in birth rates is delayed and the difference between the birth and death rates causes the population to increase.

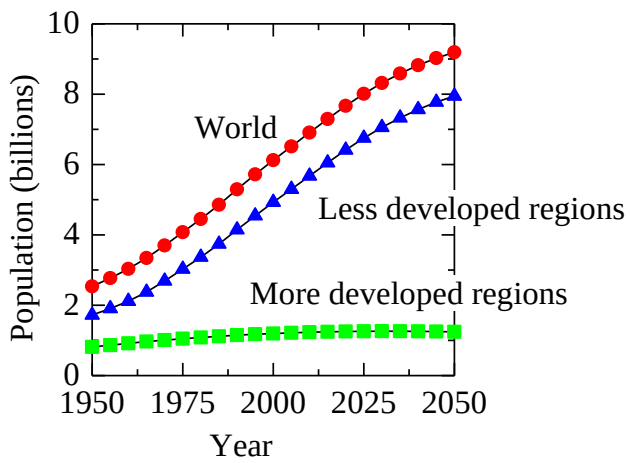

Figure 3. Current and predicted world population (source: United Nations (UN)).

Population is not exploding, but appears to be stabilizing. However, it would be better if the stabilization could be slightly accelerated. Several population control measures have been considered, e.g., the one child policy in China, which was considered inhuman and collapsed in 2015. Despite this setback, Chinese policymakers should be acknowledged in this regard because the Chinese, and the global, population would have already exploded if the policy had not been adopted. An alternative two-child policy would be very effective if it were adopted by the United Nations (UN).

The author would like to propose financial aid for the education of women and free distribution of condoms to accelerate population stabilization. The former has proven to be effective in decreasing the birth rate and has already been offered as a form of Official Development Assistance (ODA). The delivery of such assistance needs to be improved because the money does not always reach where it is needed. The free distribution of condoms alongside effective sex education can contribute to a decrease in abortions and sexually transmitted diseases, including HIV infection.

Problems after Population Stabilization

Depletion of energy resources

There are reserves (the amount that can be extracted or excavated and sold to the market) of energy resources for 153 years if oil shale and methane hydrate are included (Fig. 4). Primary energy consumption will increase in the future, but reserves also increase due to technical innovations. The figure of 153 years can therefore be used as a very rough estimation of how long we can use the existing energy resources at the current rate of exploitation. It could be considered that the existing energy reserves are sufficient for more than 100 years. If we consider the world 100 years before the present day (i.e., 1916, World War I), coal and steel were used widely, but there were no jet planes, personal computers, smart phones, plastics, aluminum, or nuclear power plants. It is apparent that the technology used in the year 2116 cannot be imagined in 2016.

There are also the nuclear fuels of thorium (reserves for 58 years) and seawater uranium (reserves for 1,000 years) for use in light water reactors (LWR). Seawater uranium could be used as the primary energy source for the whole world for two billion years using fast breeder reactors (FBR). The Earth will become uncomfortable for humans in two billon years due to the acceleration of nuclear fusion in the Sun, the slowing of the planet's revolution, and water depletion by leakage from the poles and the slowing of plate tectonics. This means that humans will not face extinction due to exhaustion of energy resources. It would be a sensible policy to secure some energy resources for two billion years, while searching for much better energy resources.

Nuclear wastes could be disposed of in the Sun, with transport from the Earth's surface on space elevators, each of which consists of a space terminal in geostationary orbit, a cable to the Equator, an outward cable, and a climber or climbers on the cable between the terminal and the Earth. The tension of the cable would need to be very high and the elevator could not be built with existing materials. However, recently, the carbon nanotube was developed and the theoretical construction of the elevator was enabled. Obayashi Corporation have claimed that they could make it by 2050.

The climber moves between the Equator and the terminal, being powered by the electricity produced from a nuclear power plant, and could transport people and luggage safely without rockets or any special training. From the outward cable, people could then

travel anywhere in the solar system on spaceships with small engines. The elevator will enable the development of energy and mineral resources in the solar system. Nuclear wastes can also be disposed of in the Sun from the outward cable. The waste will be decomposed into plasma, with the mass of the waste being so small that it would not affect solar activity.

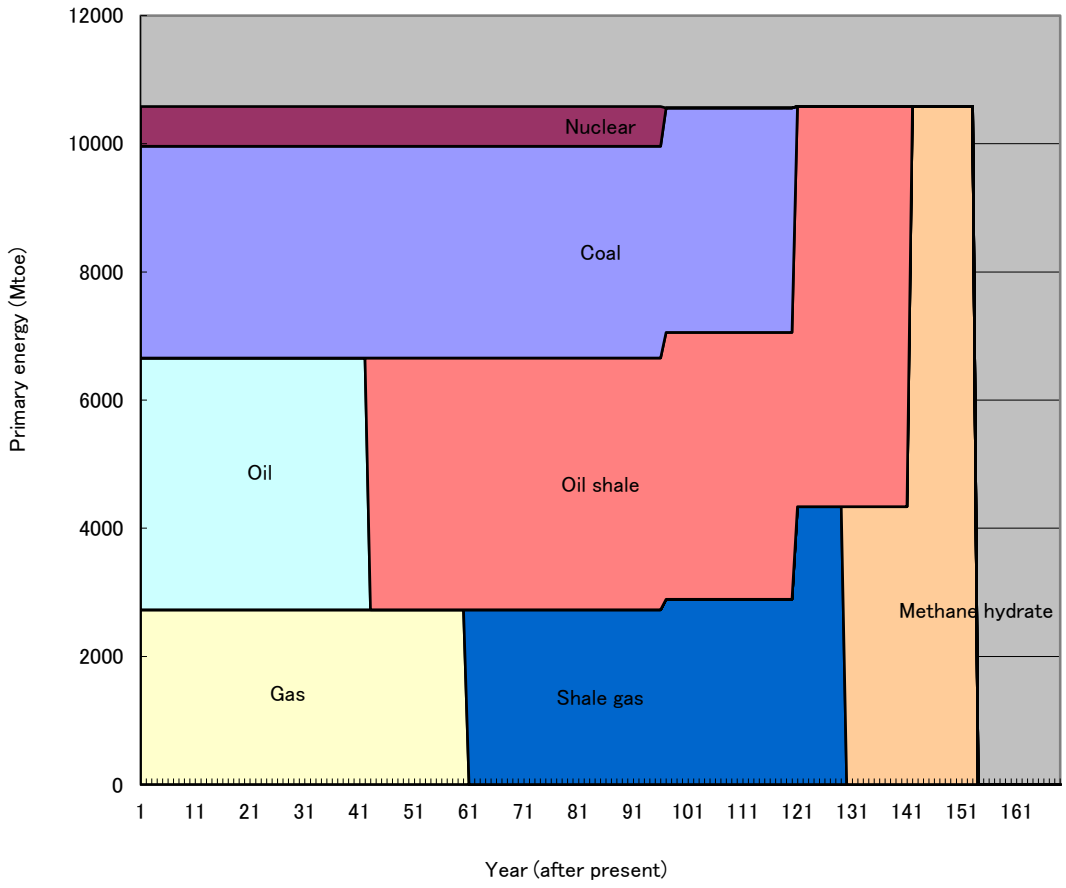

Figure 4. Reserves of energy resources, including oil shale and methane hydrate [1].

Depletion of mineral resources

In terms of production ratios, the reserves of some mineral resources are enough for only several decades. This does not mean that the mineral resource will be exhausted in several decades but, rather, that mining companies have only secured proven mineral resources for several decades to save exploration costs and to prevent a decline in prices. Mineral resources have never been exhausted and will not be exhausted for at least 100 years. However, more effort should be made to secure mineral resources.

Food crises

The amount of food currently produced is sufficient for the world population [2], and global warming by 2~3 K would increase world food production (IPCC). The Japanese, are currently producing only 38% of their food domestically, but are importing enough food and even waste some portion of this. The problem is not an environmental issue, but is

caused by poverty, due to politics.

Water shortages

Water is already in short supply. Fresh water can be produced from sea water using the almost infinite electric power available from sea uranium and FBR. However, the Fukushima accident in 2011 was a setback for this optimistic solution. Population stabilization needs to be slightly accelerated to prevent the worsening of the water shortage problem. Drip irrigation is strongly recommended to save water for agriculture.

Global warming

The pace of global warming has been slowing down in the 21st century, although the atmospheric CO_2 concentration continues to increase (Fig. 5). Sulfate aerosols from such giant eruptions as Pinatubo in 1991 reach the Stratosphere, act as a shield to reduce insolation, and decrease the air temperature. However, there have been no such giant eruptions in the 21st century (Fig. 5). The cause of the slowdown in global warming could be a lack of solar activity. The sun-spot numbers increase when the Sun is active and *vice versa*, and there are very few sunspots at present (Fig. 5).

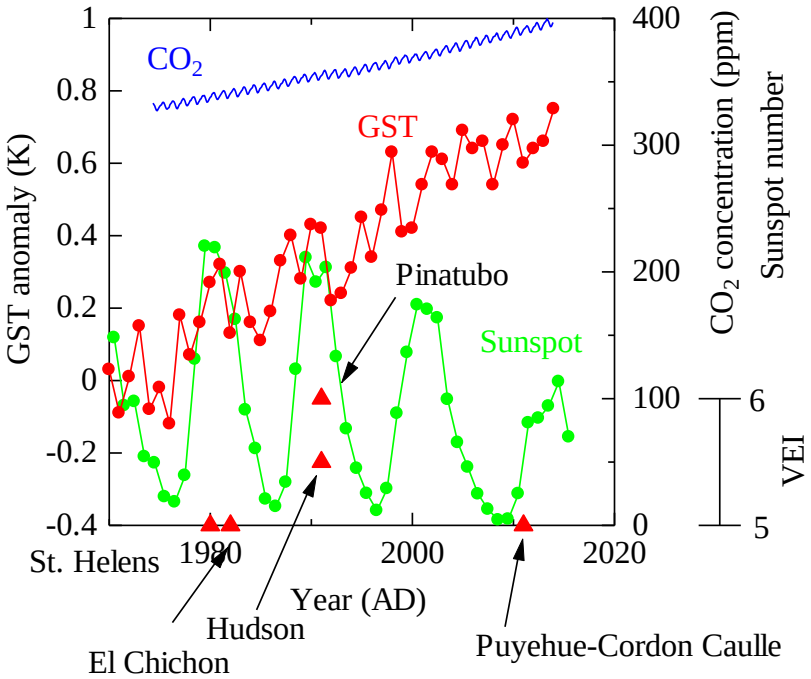

Figure 5. Recent global surface temperature (GST) anomaly (source: NASA), CO_2 concentration at Hawaii (source: National Oceanic and Atmospheric Administration (NOAA)), sunspot number (source: Sunspot Index and Long-term Solar Observations (SILSO)) and Volcanic Explosivity Index (VEI) by eruptions (source: United States Geological Survey (USGS)).

Observations of sunspots began in 17th century. The number can also be estimated by

isotope analyses of beryllium [3], with the results suggesting that solar activity in the late 20th century was rather abnormal, and the Sun has been as inactive as it presently is for most of the last 10,000 years. The Sun usually has two poles. However, the National Astronomical Observatory of Japan (NAOJ) and the Institute of Physical and Chemical Research (RIKEN) have reported that the Sun is changing, to have four poles. The National Aeronautics and Space Administration (NASA) and NAOJ have reported that solar activity has become weaker in the past 20 years (June 1, 2012 on Hokkaido Shimbun Press).

It is believed that a quadrupole Sun previously occurred during the Maunder Minimum when almost no sunspots were observed. This period is called the Little Ice Age, and it was so cold globally that it snowed in June in New England, people enjoyed skating on the Thames River in London, the Sumida River froze, and people had difficulty with transportation in the City of Edo.

If the Sun's output becomes weaker, the conditions of the Little Ice Age may be experienced again. Therefore, CO_2 emissions should be increased to maintain a comfortable climate. If the Sun remains in the present situation, CO_2 emissions should not be decreased to avoid global cooling. If the Sun becomes active again, we will have global warming, as projected by the IPCC.

Even if we experience the global warming projected by the IPCC, an unreasonable CO_2 reduction should not occur. This is because CO_2 reduction is not a cost effective solution. For example, a 50% CO_2 reduction until 2050 will reduce the rise in air temperature by 0.7 K (IPCC), but this would result in an economic loss of more than 5.5% (IPCC), which corresponds to three Lehman shocks. It is possible to adopt oxygen combustion, in which oxygen is separated from the air and used in boilers, which would make the separation of CO_2 from exhaust gases easier for carbon capture and storage (CCS) processes. However, if this was applied to coal power plants, 20~30% more coal would be required to generate the same amount of electricity, which would cause energy crises.

Some of the attempts to mitigate global warming would actually increase CO_2 emissions. For example, fuel cell vehicles use hydrogen. However, most hydrogen is generated through the chemical reaction between natural gas and high temperature water vapor, which generates CO_2. This CO_2 is then released to the atmosphere. Fuel cell vehicles are also expensive. The reason for the high price is the large amount of energy and resources consumed to manufacture them. The author compared the environmental impacts of gasoline, electric, and fuel cell vehicles, as well as walking and running; cheap and sports bicycles, a scooter, and public transport were also compared, based on cost, and concluded that either a cheap bicycle or a scooter had the least environmental impact, a US big gasoline vehicle has the largest environmental impact and the environmental impact of a fuel cell vehicle is as large as that of the US big gasoline vehicle [4].

The environmental impacts of solar power are also greater than those of fossil fuels because the production cost of 49 JPY/kWh is much more expensive than that of, for example, coal, i.e., 10 JPY/kWh even including the fee for the right to emit CO_2 (figures for Japan). Solar power is expensive because of the large amounts of energy and resources required to produce solar panels, and this energy is currently produced by fossil fuel. Manufacturers of solar panels are currently earning money and buying more fossil fuel than that can be saved by the use of solar panels. Therefore, it is more desirable to buy fossil fuels than solar panels. The fact that all societies that have depended on wood (e.g., Easter Island) have collapsed [5] should also be considered. Using solar panels is the same as depending on wood. The world is not collapsing because we are using fossil fuels,

which can be regarded as stored solar energy, and nuclear energy, which can be regarded as stored energy from past super nova.

The efficiency of coal power plants in the US, China, and India should be improved to the Japanese level so that world CO_2 emissions can be reduced by 1.3 billion/y. This is more than the amount of CO_2 being emitted by Japan and corresponds to the use of 216 nuclear power plants. The reduction enables to stop construction of 216 nuclear power plants or abolish 216 existing nuclear power plants. Geoengineering techniques, such as placing controllable objects at Lagrange points around the Earth, where the gravity forces from the Sun and the Earth are in equilibrium, so that the objects would not need any engines, to adjust insolation would also be very effective.

Devastating Disasters

Giant earthquakes at subduction zones and large-scale earthquakes directly underneath big cities

Approximately 130,000 people in Indonesia, India, Sri Lanka, and Thailand were killed by a giant tsunami following the 2004 Sumatra earthquake. Approximately 20,000 people in Japan were killed and Fukushima nuclear power plant was completely destroyed by the giant tsunami caused by the 2011 Tohoku earthquake. Earthquakes similar to the 2011 Tohoku earthquake are considered to occur once every thousand years at the subduction zone.

There have been many attempts to predict earthquakes, including predictions based on lunar phases [6]. Although some techniques have succeeded in predicting earthquakes, most attempts have failed and it can be said that there is no method to predict earthquakes that is as reliable as weather reports. Even when a reliable method is developed, predictions would only help to slightly reduce damage from earthquakes. Long-term predictions, such as "a giant earthquake will occur in 30 years with an 80% probability" can only lead to the reinforcement of buildings.

The author would like to propose the prevention of earthquakes by injecting water into the seismic faults that cause large-scale earthquakes underneath big cities. For example, an *M*6 earthquake occurs in Kumamoto, Japan, approximately once every hundred years. This seismic energy would be released by 1,000 *M*4 earthquakes, i.e., 10 earthquakes a year, or approximately one earthquake a month. The water injection can occur on a regular schedule and residents can prepare for the earthquake. The injection volume can be calculated as follows:

$$M_{\max} = 0.75 \log V - 0.48 \tag{1}$$

where $M_{\max}$ is the maximum magnitude of the induced earthquakes, and V is the injection volume of water [7], i.e., 49 tons per injection. Careful investigations should be undertaken before proceeding with the injection. However, the prevention of earthquakes can result in negligible earthquake damage. This is much more effective than unreliable earthquake predictions, which at best could only reduce the level of damage. The risk and cost of these practices are under investigation by the author.

Giant earthquakes at subduction zones cannot be prevented by such injections because the seismic sources are far deeper than the currently feasible drilling depth. Russian research has shown that giant earthquakes ($M \geq 8$ by definition) did not occur during the period when underground nuclear explosion experiments were conducted. This result may

imply that the vibration from the underground nuclear explosions induced numerous smaller earthquakes, thereby releasing seismic energy that would have been later released in giant earthquakes. It is possible that vibrations induced by some technique could be used to prevent giant earthquakes at the subduction zones. It may not seem to be feasible to resume underground nuclear explosions. However, we can explode existing US and Russian nuclear warheads underground to prevent giant earthquakes thereby reducing the number of warheads. Careful investigations should be undertaken before proceeding with the explosion of course.

Catastrophic volcanic eruptions

If the active supervolcano in Yellowstone National Park in the US erupts, 90% of all people within 1,000 km will be choked to death by volcanic ash. The air temperature of the Northern Hemisphere will fall by 10 K, with a cold climate continuing for 6~10 years because sulfate aerosols from the eruption will reach the stratosphere and shield insolation. It would not be feasible to evacuate people to the Southern Hemisphere because the air would be so hazy that airplanes could not fly. Populations remaining in the Northern Hemisphere would face starvation and, eventually, extinction because food could not be grown under such conditions.

The supervolcano erupted approx. 2.2 million, 1.3 million, and 640 thousand years ago and it could erupt again at any time. The probability of eruption is 0.19% within 1,000 years, 1.9% within 10 thousand years, 27% within 100 thousand years, and 100% within 1 million years. Catastrophic eruptions can be predicted by means of precise observations by dedicated researchers who understand volcanic activity extremely well, such as occurred with the eruption at Mt. Usu in 2000 in Japan. Such predictions could slightly reduce the damage experienced following the eruption, but would not ultimately prevent the extinction of humans in the Northern Hemisphere.

Humans will survive because people in the Southern Hemisphere will eventually move to the Northern Hemisphere and begin to develop the land. However, to prevent the extinction of humans in the Northern Hemisphere, catastrophic eruptions should be prevented. This could be enabled by gradually releasing energy with magma power generation, in which a hole or holes are drilled toward the magma, fluid is circulated and heated by the magma, and finally the heat is exchanged at the ground surface. The methodology and cost are now under investigation by the author.

Giant meteorite impacts

The diameter of the meteorite that caused the extinction of the dinosaurs and made the Chicxulub crater was approximately 10 km. The energy was equivalent to $M12.9$ or 10^{14} MT trinitrotoluene (TNT) explosives, i.e., 6.7 billion times that of the Little Boy atomic weapon that was dropped on Hiroshima, Japan, by the US on August 6, 1941, or 200 thousand times that of Tsar Bomba, which was the largest hydrogen bomb produced by Russia and was detonated at Novaya Zemlya. Humans would be made extinct if a meteorite of this size impacted the Earth. Meteorites of this size impact the Earth at a rate of 1 per 100 million years. Smaller meteorites impact more often. NASA operates the Near Earth Object (NEO) Program and 367 objects that could impact the Earth have been identified.

For example, Apophis will pass under the orbit of communication satellites on Friday, April 13, 2029. It will pass again in 2036 and might impact the Earth, although the probability is just 1/2,000,000. However, if it impacts the Earth, the energy released would

be *M*9.4 or 506 MT of TNT explosives, i.e., 34,000 Little Boys or 10 Tsar Bombas. The west coast of the US, Hawaii, Japan, the Philippines, and Indonesia would be completely destroyed.

To prevent such a disaster, the Space Guard Project has been established. The project aims to slightly change the orbits of meteorites to prevent impacts. This project can be considered to be much more important than global warming mitigation.

Concluding Remarks

There will be no energy, mineral or water crises if population stabilization is slightly accelerated. Global warming is slowing down and will not be a severe problem if population stabilization is slightly accelerated and the efficiency of coal power plants in US, India, and China are improved. The slight acceleration of population stabilization will be enabled by improving the education of women and free condom distribution in developing countries. In addition, a two-child policy would be very effective if it were adopted by the UN. Rather than worrying about the above problems, techniques to prevent devastating earthquakes, catastrophic volcanic eruptions, and the impaction of giant meteorites should be developed.

For further human survival, up to two billion years into the future, sea uranium and FBR should be developed. Nuclear wastes can be disposed of into the Sun from space elevators, which could be built with carbon nanotubes within 50 years.

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