

The Overview of Research on Global Change

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ABSTRACT

Recently many parts of world suffer from chaotic weather. Many scientists believe that this is due to the human made green house emissions, mainly carbon-dioxide. Apart from this various pollutants also affect the Earth's environment. These global changes could become a great threat to human survival on the Earth in the future. Therefore many countries are putting great efforts into the study on the global change. This research should take into account whole field of earth sciences. so it becomes interdisciplinary by nature. This will help us to understand the complicated and subtle nature system of the Earth.

1. Introduction

Recently the global changes of the nature, the Earth's environment, have been a hot issue. The environment of the Earth is very complicated and many variables are dependent upon each other. For EOS program, NASA's 17 satellites will chart more than 800 variables (Popular Science, 1992) – ranging from the level of greenhouse gases to the abundance of plankton in the ocean. Such many variables are crossly related each other strongly or weakly. Due to this reason it is very difficult to estimate the final result of any inputs, therefore only fragmentary studies have been carried out so far.

There had been several mass extinction's during the entire Earth's history. e.g. the extinction of dinosaur in the Jurassic eon. It is thought that the cause would be the "Nuclear Winter Effect" after being hit by a small asteroid of few kilometers diameter. Previously that kind of global change occurred because of purely natural causes. however recently man made pollutants could be another cause. Since the Industrial Revolution in the 18th century many factories have produced carbon-dioxide and other pollutants. As the result the carbon-dioxide in the atmosphere has increased by 30 %

compared to the level of before the Industrial Revolution (Mackenzie & Mackenzie, 1995).

There have been many environmental disasters recently; global warming, ozone depletion, and chaotic weather, especially torrential rain in the East Asia including the flooding of Yangtse river this year. It is thought that human activities are mainly or partly responsible. In the past it was impossible to monitor the global change because of the lack of proper platforms and instruments. However nowadays satellites are available and these make it possible to study the global changes. In July of 1999 the KOMPSAT-1 will be launched, so Korea can contribute to the worldwide efforts for studies of the global change.

2. Global Factors

There are many factors for global change; natural factors and anthropogenic factors.

- Tectonic Activities
 - Volcanic flumes; releasing gases and dusts
 - Circulation of mantle
- Global Circulation of Chemical Species
 - Carbon-dioxide (CO₂); global warming
 - Nitrogen (N₂)
 - Oxygen (O₂)
 - Sulfur (S)
 - Phosphorus (P)
- Albedo change; due to aerosol in atmosphere and melting glaciers in the arctic area
- Anthropogenic Impact
 - Population; it will increase up to 8.8 billions by the year 2070 (Chosunilbo, 1998)
 - Carbon-dioxide(CO₂); most important effect on the environment by causing global warming
 - Agriculture; destroying forest and spraying chemicals
 - Deforestation in the tropical region
 - CFCs; Ozone depletion and global warming
 - Pollutants; acid rain
- Variation of solar energy
 - 11 year cycle of sun spot change
 - 100,000 years cycle of eccentricity change in the Earth's orbit

(Milankovitch) (Mackenzie & Mackenzie, 1995)

- Comet impact: large scale extinction's every 100 million years

3. Global Warming

Nowadays it has become the most important hot issue after the ozone depletion problem. In 1993, 7 billion tons of carbon-dioxide was produced by human activities and 3.2 billion tons was accumulated in the atmosphere. Due to this the carbon circulation of the Earth is unbalanced. The concentration ratio of carbon-dioxide is 360 ppm which is increased by 30 % (85 ppm) compared to the value of 300 years ago (Meckenzie & Meckenzie, 1995).

Due to this man made carbon-dioxide the average temperature increased by 0.6°C between 1856 and 1995 (Figure 1). It is expected that the temperature will rise by 1.0 ~ 3.5°C until the year 2100 (Brown et al., 1997).

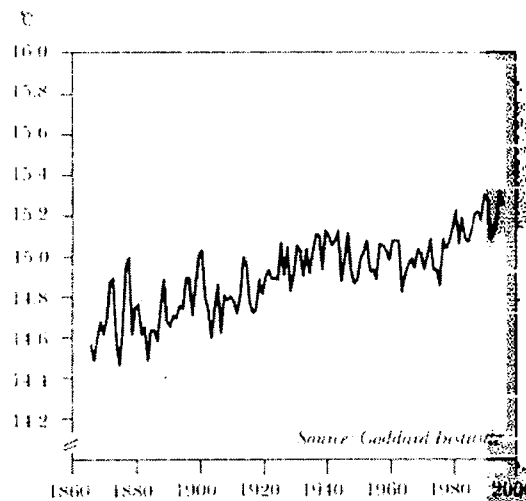


Figure 1; Average global temperature between 1866 – 1995 (Brown, 1997)

This temperature increment might put more energy into the atmosphere, so the Earth's energy balance could be disturbed leading to changes in the global circulation pattern of the atmosphere and ocean. As a consequence the weather may become more extreme and violent, for example;

- Expansion of drought region; expansion of the Saharan desert

- More destructive typhoon and hurricane
- Chaotic weather; torrential rains in the East Asia

It may be true that as the mean temperature increases the Earth becomes warmer and will have more rain. So some regions of the Earth may turn to be more suitable place for living and farming. However things are not simple as we hope, in addition to above negative effects biological environment system may be disturbed;

- Rampancy of disease; malaria and other tropical diseases
- Explosion of noxious insects; more early hatching and more rapid growth and moving
- Increasing sea level causing submersion of coastal area

All these factors could damage agriculture, and ultimately it may lead to food shortage. To overcome the attacks from insects and diseases it is required to maintain the biological varieties of farming plants as well as to reduce greenhouse gases.

4. Modeling the Global Change

The final goal of studying global change is to find the state of “Sustainable Development” as predict the future. To achieve these it is necessary to model the Earth’s environment, in which natural environment and ecosystem are included. It is very complicated system; nonlinear, non-equilibrium and multi-variable system. The characteristics of the Earth’s environment are depicted below

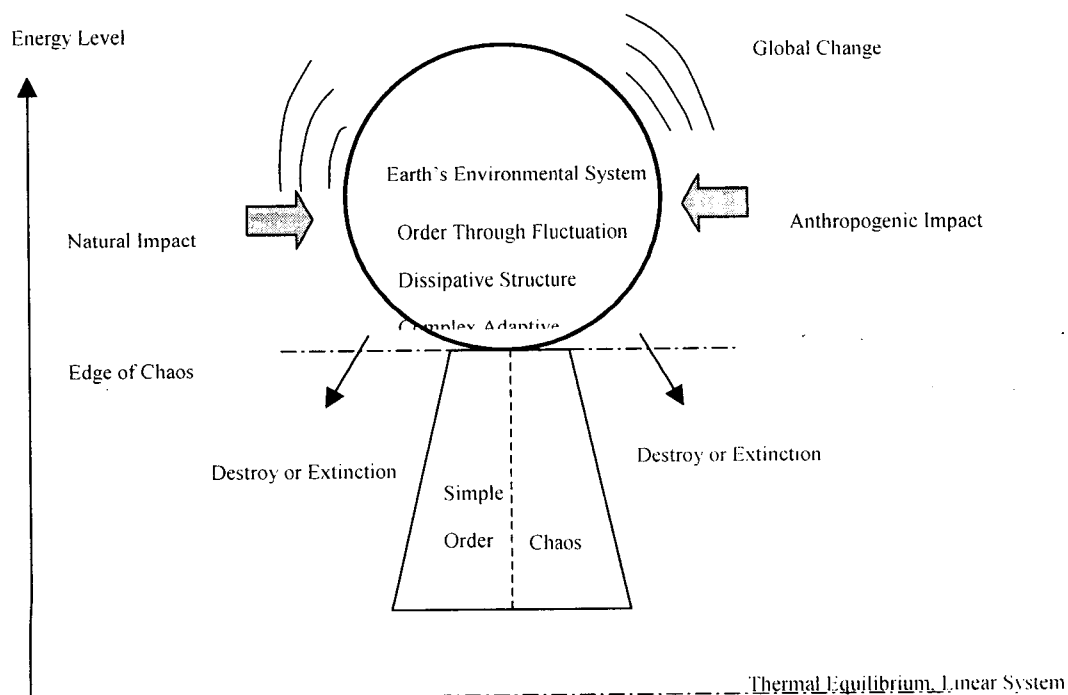


Figure 2; Schematic diagram of the Earth's environment system

Some variables have positive feedback. e.g. albedo and atmospheric temperature, so a tiny input disturbance could be amplified and causes a catastrophic result. Unfortunately we do not know the threshold of the runaway phenomenon. Through the modeling study we will be able to find out the threshold values. However it is in the beginning stage, so it will be more effective to use satellite data accompanied with model.

5. Conclusions

Recent human activities impact on the Earth's environment, so they cause global change, such as ozone depletion and global warming. So it is very important to predict the future impact to prevent catastrophic environmental hazards.

However, unfortunately, the Earth's environment is complicated, more than 800 variables are involved, non-linear and non-equilibrium system. Hence the conventional method based on the Newtonian deterministic concept might not be adequate to handle it. Recently developed chaos theory and non-equilibrium dynamics are considered to be promising to deal with this problem.

In accordance with modeling effort it is also required to archive global environmental data from satellite. Analyzing satellite data is now the only reliable method to predict the future. For this reason the KOMPSAT-1 will be very useful to study the Global Change.

Reference

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