Geographical Relations Dynamics (3)
- on a material basis vs. on a monetary basis -

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Abstract:- In environmental science, there are two types of approaches. One is an approach on a material basis represented by D. L. Meadows and his colleagues' "World Dynamics". Another is one on a monetary basis which most of environmental economists take. The author presented studies following the material basis approach at EED '06 and EEEDS '07. Where the world consists of 24 land regions, examining the relations of energy, GHG, and food production and consumption, in the relation with world trade. In this paper, the author examine the relationship between material basis (atom) and monetary basis (money, i.g., information ,bit) From this viewpoint, the author emphasizes the significant contribution by China and India in the near future and estimate when and how their negative effects would and could get slow down, according to W.W.Rostow's criteria and suggests the forthcoming the Kondratiev's fifth cycle around 1930.

Keywords:- World Dynamics, Geographical Relations Dynamics, GHG (green house gas), Stern's Report,Rostow's model, Kondratiev's cycle

1 Introduction: Study on a material basis

1.1 Parameters in World Dynamics

D. L. Meadows' team selected four parameters such as rare metal chromium representing non-renewable natural resource, environmental stress, food production, population. Food and resouces produces environmental stress. Meadows created a mathematical function that an environmental stress makes the man's average life shorter as a negatigve feedback [1].

Major difficulties on this type of study would be how to obtain reliable and consistent worldwide data. When Meadows' team began their research around the mid 1960s was the time when international organizations such as UN and FAO barely started to publish their worldwide statistics.

1.2 Parameters in Geographical Relations Dynamics

While Meadows' team deals with the world as a point, the author has proposed a geographical model which consists of 24 land regions in 9 x 10 meshes on Earth (Fig.1). The author selects four parameters the following: [2][3][4]

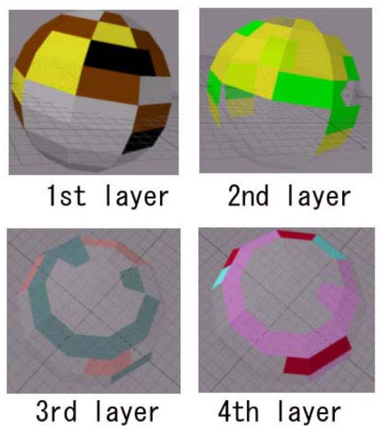

Figure 1: Regions and layers in Geographical Relations Dynamics

- energy: In this paper, energy means the total energy which combines oil, coal, gas, and all other energy sources together in unit of Kcal [6]. (Layer 1 in Fig.1)

Table 1: Parameters in World Dynamics and Geographical Relations Dynamics

parameter (unit)	World Dynamics [1972]	Geographical Relations Dynamics
resources	non-renewable resouce Cr (ton)	Energy production (Kcal)
environ-ment	environment contamination increase mortality	Green House Gas emission CO2 (ton)
food	food (Kcal) consumption per capita	food production (Kcal)
popula-tion	(men)	food (Kcal) consumption

- GHG (green house gas i.e., CO2) emission based on UN statistics[5]. (Layer 2)
- food: production and consumption in unit of Kcal based on FAO annual statistics (Layer 3)
- population in each region based on UN population census. (Layer 3)
- Layer 4 is assigned to monetary activity (information).

We adopt Kcal standing for energy, food production, and population (food consumption). Green House Gas emission is measured by weight unit (i.g.,ton). There is a correlatioship between energy (Kcal) and CO2 emmision (ton) so that it becomes possible to understand the regional and world problems consistently.
Table 1 is a comparison of parameters used in World Dynamics and Geographical Relation Dynamics.

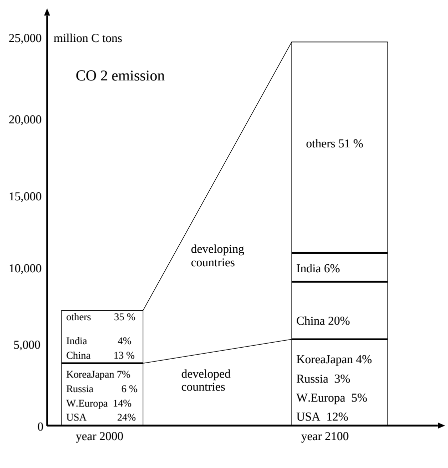

Figure 2: Estimation of CO 2 emission in 2000 and 2100 (after RITE)

2 Bridging between a material basis and a monetary basis

As for the future GHG (represented by CO2 gas), there are many simulation results. Figure 2 shows a simplified diagram of one of those estimations done by RITE, a Japanese governmental research organization[7] Today, USA is being blamed because she would not ratify the Kyoto Protocol, while she is the largest CO2 emitter. However, figure 2 indicates a different view in 2100. Today, developed countries such as USA, Russia, Britain, Germany, France, Italy, Japan and Korea make up almost half of CO2 emission. But, in process of time, emission ratio of developing countries will increase significantly. In 2100, China and India would emit far larger CO2 than today's developed contries'altogether. This type of discussion uses Kcal or ton i.g., on a material basis.

2.1 Stern report

In 2006, British government published the Stern Report[8] The report bridges the relations between the possible harzard caused by CO 2 emission (e.g, ton, i.g., on a material basis) and man's economic activity (e.g. US $, i.g., on a monetary basis). If man would not input any money onto the environmenmtal problems, it would result 20 % of world GDP losses to the maximum in the foreseeable future. On the other hand, the report implies that if only 1 % of today's world GDP would be input to deal with the global warming problem, it might not cause a serious GDP losses in the future. bbb Up to now, environmental scientists and environmental economists have been discussing the problem either on a material basis (e.g., ppm of chemical pollutant) or on a monetary basis, such as "marginal external cost" or "abatement cost". In order to bridge two types of discussions, an idea proposed by N. P. Negroponte of Media Laboratory, MIT might be useful[9]. He distingushes atom (material) and bit (information). CO2 gas is atom, while money is bit in this sense. The price of oil (e.g., 1 barrel of crude oil costs more than 50 US &) means that bit (US $) is anchored with atom (oil) in real economy. However, money in the international exchange market or some exessive liquidity for speculation manipulated by hedge funds may not be anchored with real economy. In Geographical Relations Dynamics, we assign layer 4 to money.

2.2 Energy and food on a monetary basis and GDP in different regions of the world

At EEEDS'07, the author presented the estimation of energy (regional production, international trade, and regional consumption) and food in the

Table 2: Energy production in 2000 (billion US $)

Polar Canad 14.0	North EU 132.6	Rusia 10.0	Cent. Siber. 321.0	East Siber. 18.4	
N Ame rica 759.8	South EU 283.0	Caspi an 38.6	C Asia 53.7	N China 131.7	Korea Japan 64.0
C Ame rica 196.0	Sahara 106.7	Arab 432.2	India SEasia 128.6	S China 131.7	
Ama zon 41.2	Congo 46.8				mari Asia 105.5
Patago nia 40.5	S Africa 64.9				Ocea-nia 93.2

Table 3: Food production in 2000 (billion US $)

Polar Canad 1.6	North EU 21.8	Rusia 24.1	Cent. Siber. 1.3	East Siber. 1.3	
N Ame rica 131.8	South EU 74.6	Caspi an 20.5	C Asia 9.4	N China 78.9	Korea Japan 8.8
C Ame rica 15.3	Sahara 14.5	Arab 10.0	India SEAsia 124.5	S China 78.8	
Ama zon 44.1	Congo 54.8				mari Asia 28.4
Patago nia 24.5	S Africa 8.1				Ocean-nia 11.9

same manner in 2030. They were expressed on a material basis (Kcal). We examine the interelations of energy(Kcal), CO2 emission(ton), and food (Kcal) in 2030 based on statistics prepared by various international organizations.

- a positive correlation of energy consumption and CO2 emission in different regions of the world.
  y = 2.7833x - 377.14 (R2 = 0.6555) where:
  y : CO2 emiision (million ton)
  x : energy consumption (12 power of 10 Kcal)

- so-called food crisis might be less anyhing to do with other parameters (energy and CO2).

Table 2 shows the regional energy production in unit of billion US $, where the exchange rate of Kcal and dollar is **50 US $ for 1 barrel crude oil**. If expensive than 50 US $, it encourages development of coal gastification, solar energy power and other alternative energy sources.
Table 3 shows the regional food production in billion US $, assuming that the price of corn represents all other food. Due to bio-mass popularity, 1 ton of corn costs more than **250 US $** today.
Finally, regional GDP are shown in Table 4 for reference. Where meshes consist of ; *East Siberia*: Far East province of Russian Federation (Rus.), *Central Siberia*: Siberia province of Rus., *Russia*: remaining provinces of Rus., *Central Asia*: Uzbekistan,Kyrgystan,Turkmenistan,Mongolia,Shinjang Uyghur, Tibet, *Alaska*: Alaska (USA) and Yukon (Canada), *Polar Canada*: Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario of Canada, *New Foundland*: Quebec, New Brunswick, NovaScocia, New Foundland, Prince Edward Is of Canada. Individual GDP values for member states and provinces are available.

Table 4: GDP in 2005 (billion US $)

Polar Canad 554.8	North EU 864.6	Rusia 469,2	Cent. Siber. 83.2	East Siber. 28.6	
N Ame rica 12104	South EU 12758	Caspi an 392	C Asia 94.9	N China 1108	Korea Japan 5342
C Ame rica 1134.5	Sahara 306.4	Arab 934.6	India SEAsia 986.8	S China 1228	
Ama zon 681.4	Congo 225				mari Asia 578
Patago nia 297.9	S Africa 298				Ocean-nia 746

2.3 W.W.Rostow's model: The Stages of Economic Growth

In order to estimate the feasible effects caused by developing contries especially by China and India, we better use an economic model created by W. W. Rostow[10]
He classified the economic growth the following:

- the traditional society
- the precondition for take off
- the take off
- the drive to maturity
- the age of high mass-consumption

He identified the specific time of "take-off" for major countries (Table 5):

Table 5: The period of "The take off"

country	period	country	period
Britain	1783-1802	Japan	1878-1900
France	1830-1860	Russia	1890-1914
Belgium	1833-1860	Canada	1896-1914
USA	1843-1860	Algentina	1935-
Germany	1850-1873	Turkey	1937 -
Sweden	1868-1890	India China	1952- 1952-

2.4 A case study of modern Japan

Starting from "take-off" to the age of "high mass consumption", western European countries and USA took more than hundred years so that over all growth rate was about 2 percent. To examine fast development of China and India today, the case study how Japan have developed and how she is stagnant today might be useful. We can identify three period according to average annual growth rate after the world war II in Japanese economic development (Table 6). We can identify different socio-economic characteristics in three periods respectively (Table 7). Figure 4 shows how a diet habit change as economy develops. While the cerial intake (Kcal) decreases, the animal protein intake increases so that feeding (Kcal) increases.

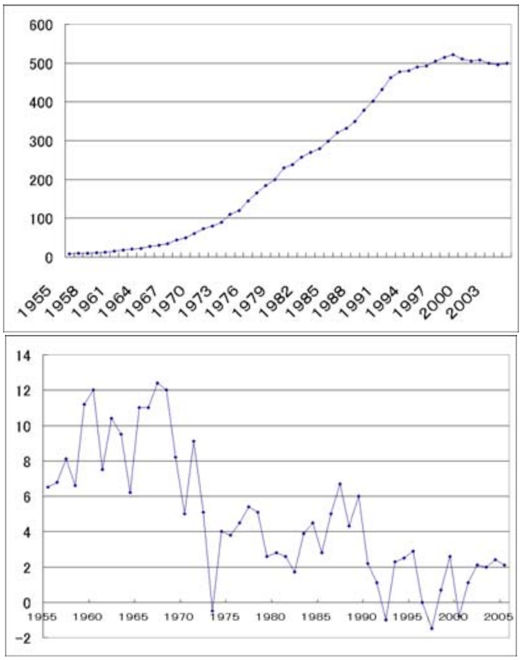

Figure 3: GDP growth (billion yen) and growth rate (percentage) of Japan 1955-2004 (after Min. of Public Management, Japan

Table 6: Japan's economic growth by periods

high growth period	average growth rate	middle	av. grwth rate	low	av. grwth rate
1956-73	9.1%	74-90	3.8%	91-06	1.3%

Table 7: Japan's socio-economic change

	1956-73	1974-90	91-2006
indu-stry	heavy chemical industry	automobile infra-structure	IT digital-electro home delivery
con-sump-tion	B&W-TV washer ice-box	color-TV air-cond car, house	digital-TV cell-phone Internet
pollu-tion	heavy metal smog	house-discharge	CO2
popul ation	young many kids	mid-age	elderly few kids

3 China and India

3.1 Their fast development today

Angus Madison estimated the possible GDP in 1820 about major countries[11]. He suggests China and India the greatest economic powers in the world at that time, but, then after, the Western world overtook them.
Fow a while after their "take-off" around 1952, their economies had stagnated. But China began her high growth drive since 1980 and India in 1990.The Goldman Sacks team studied what would happen if today's high growth of theirs would last to the years of 2050[12]. Even Japan can not keep her promiss on cut CO2 emission, while her energy saving technology is at the top and her economy is at the matured stage, because of *private car's CO2 emission.*

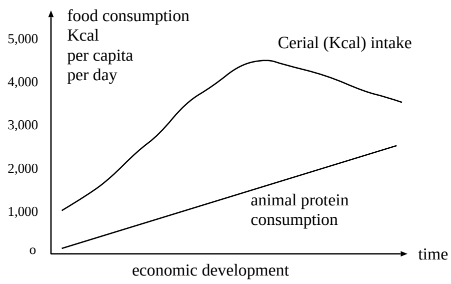

Figure 4: Diet habit change

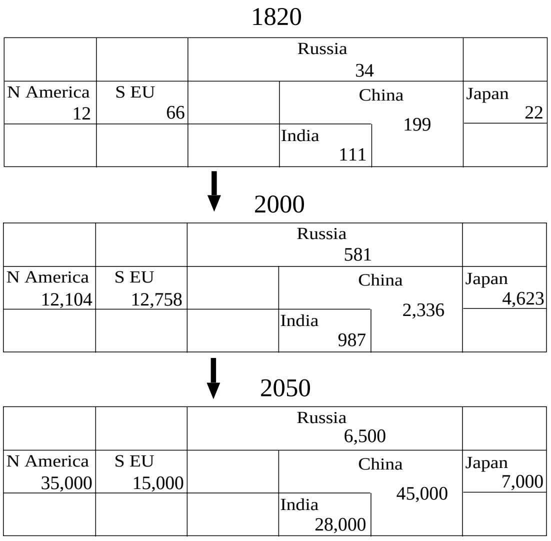

Figure 5: GDP (billion US $) in 1820, 2000, and 2050 (after Angus Madison and Goldman Sacks)

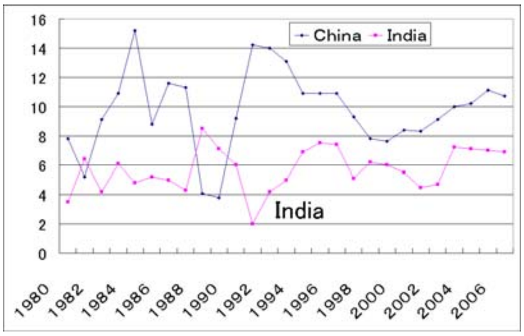

Figure 6: Growth rate (perecentage) of China and India: 1980-2006 (compiled after National Bureau of Statistics of China, India)

3.2 When they slow down ?

Eenegy Information Administration predicts that CO2 emission out from China and India would become as much as USA's in 2025[13]. When do they slow down, to ease the situation, ? To answer this question, a criteria given by W.W. Rostow could be useful. He pointed out that the watershed from the high and fast growth period to the slow down period can be defined by a car coverage i.e., when there is **one car every ten people** in the total population. This critical moment was in 1920 for USA, in 1960 for France, Britain, and Germany, in 1970 for Japan.

Figure 7 shows how car production by Japanese car makers changed from 1965 to 2003. The peak was in 1991, then the domestic market got saturated so that Toyoya and other car makers had to shift their production outside Japan. In the same manner, Figure 8 tells how car production in China and India are going on. China got accelerated around in 1990 and India has just been accelarated. Figure 9 tells the

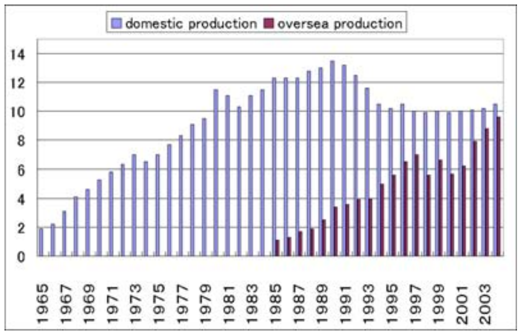

Figure 7: Car production by Japanese car makers: 1965-2004 after Japan Association of Automobile Manufacturers (million cars)

number of car owners in China. As of 2006, there is one car per every 100 Chineses. The author would like a bold prediction based on statistics avove, by analogy with Japan's experience. It might be around 2020 for China and 2035 for India when there is one car per every ten people.

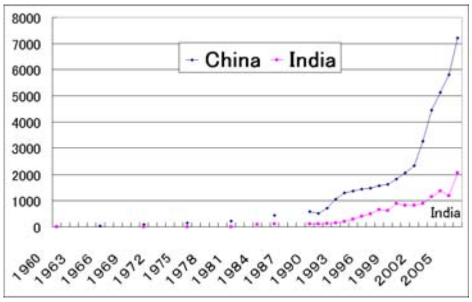

Figure 8: Car production in China and India: 1960-2005 (1,000 cars)

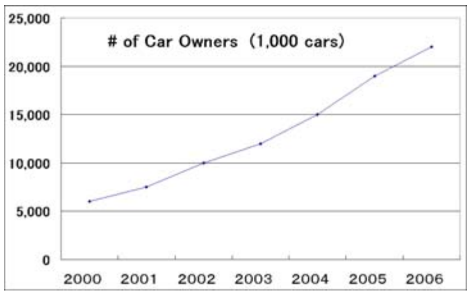

Figure 9: Car owners number in China

4 Conclusion and Discussion

4.1 General mobilization of current technologies

Since the first energy crisis in 1973, vast amount of R&D efforts have been done in developed countries in order to exploit alternative renewable energy and conservation technology. E.F.Schumacher and A.B.Lovins are representaive adovocates[14][15]. However,after 30 years of efforts, only a technology to inject excessive CO2 into the avandoned mines in deep underground becomes feasible. It has achieved only several or several tens percentage improvement of existing technologies since 1908.

4.2 the Fifth Kondratiev's cycle: Shift from metal and silicon technology to carbon technology

Russian economist N. Kondratiev (1892-1938) found the longest economic cycle (60 cyclic years). Austrian economist J. A. Schmpeter pointed out the major drive engine of this longest cycle could be *innovations*. Their successors recognize four waves so far since the Industrial Revolution which started ca. in 1771.

1. steam engine and railways (till 1829)
2. steel, electricity and heavy engineering (since 1829)
3. oil, car, and mass production system (since 1908)
4. Information and telecommunications (since 1971)

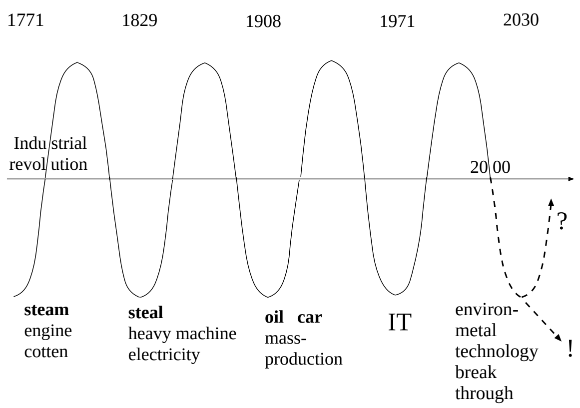

Figure 10: Kondratiev's cycle

If previous observations (Fig. 10) were correct, we might just stand along the down fall path of the fourth cycle. The worst time for the global warning would come around 2030 exactly Kondratiev predicted as capitalist crisis. The author would like to say that all energy relating technologies belong to the metal and silicon technology represented by car. The hope will come from completely new dimension something like K. Kurzweil adovocates [16].

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