

Cover Sheet of Paper 2

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Global Warming Impacts on Japan and Asian region

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Abstract

Studies on impacts and risk of climate change in Japan and Asian region are conducted by research institutes and universities under the Global Warming Research Initiative of the Council of Science and Technology Policy, which was initiated in April, 2001. From the studies, impact due to climate change were detected in various fields and regions in Japan, and future impacts and risk are predicted using various type of impact assessment models. From such model applications, severe impacts and risk will appear in Japan and Asian regions.

1. Introduction

In the early 1990s, Japan began conducting researches on the impacts and risks of global warming, the same when time international studies centered on the IPCC were proceeding. These researches covered a wide range of fields, including water resources and water environment; terrestrial ecosystems; agriculture, forestry and fisheries; marine environments; coastal zones; land preservation, disaster prevention, lifestyles; industry and energy; and human health. Recently these studies have included estimates of impacts on developing countries in the Asia-Pacific region, and adaptive measures against these impacts [1].

2. Observed and predicted climate change impacts in Japan

2.1 Changes in vulnerable ecosystems

Among the phenological observations conducted nationwide by the Japan Meteorological Agency (JMA) since 1953, the changes in the flowering date of the Japanese cherry (*Prunus yedoensis*) are particularly striking. These trees now flower 5 days earlier on average than they did 50 years ago.

There are other examples of detected impacts of global warming.

- Decreased alpine flora in Hokkaido, the north island in Japan
- Expanded distribution of the southern broad-leaved evergreen trees such as the Chinese Evergreen Oak
- Appearance in Mie prefecture in the 1990s of Nagasakiageha (*Papilio memnon thunbergii*) for which the

northern border has traditionally been Kyushu and Shikoku Islands

-Appearance in the Tokyo area in the 1980s of the southern tent spider, which was seen only in western Japan in the 1970s

-Expansion of the wintering spot of the White-Fronted Goose to Hokkaido

-Shifting habitats of ermine and grouse on mountains such as Hakusan and Tateyama to higher elevations, with some dangerous prospects for their complete disappearance

Fig. 1 shows the present and predicted distribution of beech forest. Beech forests are typical of the cool temperate zone, and are distributed widely in Japan. However, at their southern limit of the distribution,

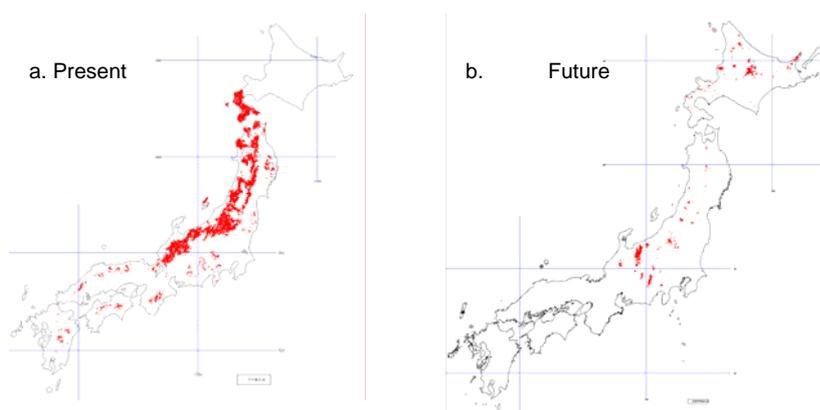


Fig. 1 The present and predicted distribution of beech forest [2].

global warming may cause the transition of these forests into evergreen forests[2].

2.2 Impacts on coastal region and disaster prevention

In Japan, cities and towns facing the ocean account for 48% of the population, 48% of industrial shipment value, and 62% of commercial sales. Currently, there

are 2 million people and assets of 54 trillion yen in areas below the high water level. With a 1 m rise in sea level, these figures would more than double to 4.1 million and 109 trillion yen, respectively. In addition, sea-level rise would reduce the function and stability of disaster prevention facilities on the coasts. To maintain the function of seawalls and dikes at their current levels against 1 m sea-level rise, seawalls should be raised 2.8 m on open sea coasts, and harbor quays be raised 3.5 m in semi-closed bay.

2.3 Impacts on industry and energy sector

As global warming proceeds people's consumption patterns will also change thereby leading to changes in industrial structure. For example, if the mean temperature in June to August increases by 1°C, consumption of summer products may increase by about 5%. And if the period of high temperatures in summer lengthens, the consumption of air conditioning, beer, soft drinks, and frozen desserts will increase, so that electronics and food producers will likely need to reinforce their production systems for seasonal goods. Various impacts may also be felt in the supply and demand for electricity (**Fig.2**). Forty percent of the power demand in summer is for air conditioning, so a 1°C rise in temperature can lead to an increase in power demand of approximately 5 million kW (amount for 1.6 million households). The generation efficiency of thermal and nuclear power plants depends on the temperature of the cooling water, and a 1°C rise in

coolant temperature will reduce the thermal power output by 0.2-0.4%, and nuclear power output by 1-2%.

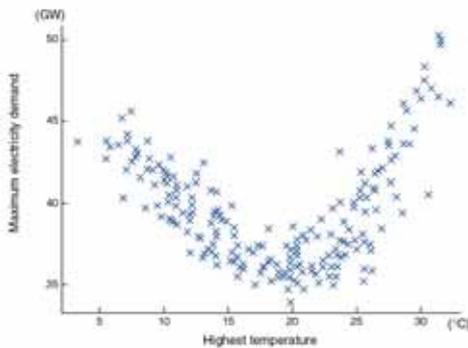


Fig. 2 Daily maximum temperature and maximum electricity demand [1]

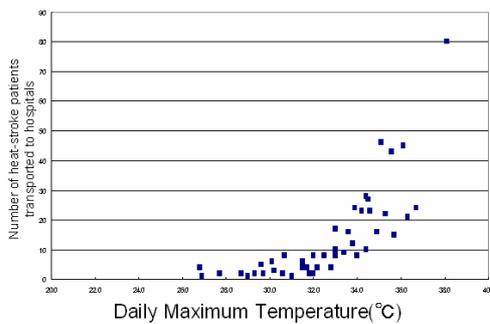


Fig. 3 Daily maximum temperature and the number of eat stroke patient who were transported to hospitals in July 2001 [1]

2.4 Impacts on health

Rising temperatures will have a direct impact on human health, with an increased overall death rate from heat stroke and other disorders. The elderly and people with underlying medical conditions will be at greatest risk. **Fig.3** shows daily maximum temperature and number of heat stroke patient, who were transported to hospitals in July 2001. Worsening atmospheric pollution and epidemics of vector-borne infectious diseases such as malaria and dengue are also possibilities. There have been recent reports of mosquitoes which transmit communicable diseases moving northward to the Tohoku region, and the risk of infectious disease may become a reality as the mosquito habitat expands.

3. Impact assessment at global scale

Studies on global impact assessment have been advanced in leaps and bounds during the last decade. By taking spatial outputs of climate models as input data, impacts on the most vulnerable sectors such as water resource, agriculture, human health, and natural vegetation have been assessed

under alternative future socio-economic/emission scenarios.

For example, by considering spatial distributions of water demand (water withdrawal is mainly affected by socio-economic environment) and supply (renewable water resource is affected by climate and land environment) simultaneously, water stress index (WSI) in each river basin has been estimated (Definition of WSI is explained in the figure) using AIM/Impact model collaboratively developed by the National Institute for Environmental Studies (NIES), Kyoto University and other institutes in Asian countries. **Fig. 4** shows the WSI in 2000 (now) and in 2100. For the projection of 2100, two alternative future scenarios ((B1) unsustainable and (B2) sustainable) were adopted. The unsustainable scenario assumes SRES-A2 socio-economic/GHG emission scenario and a low rate of water-use efficiency improvement. The sustainable scenario assumes SRES-B1 scenario and a high rate of water-use efficiency improvement. Under the unsustainable scenario,

which reflects a high rate of population increase and a low rate of water-use efficiency improvement, WSI will significantly increase especially in developing countries. It means draught risk will increase in future. On the other hand, under the sustainable scenario, WSI will not increase so much in developing countries or even slightly decrease in developed countries

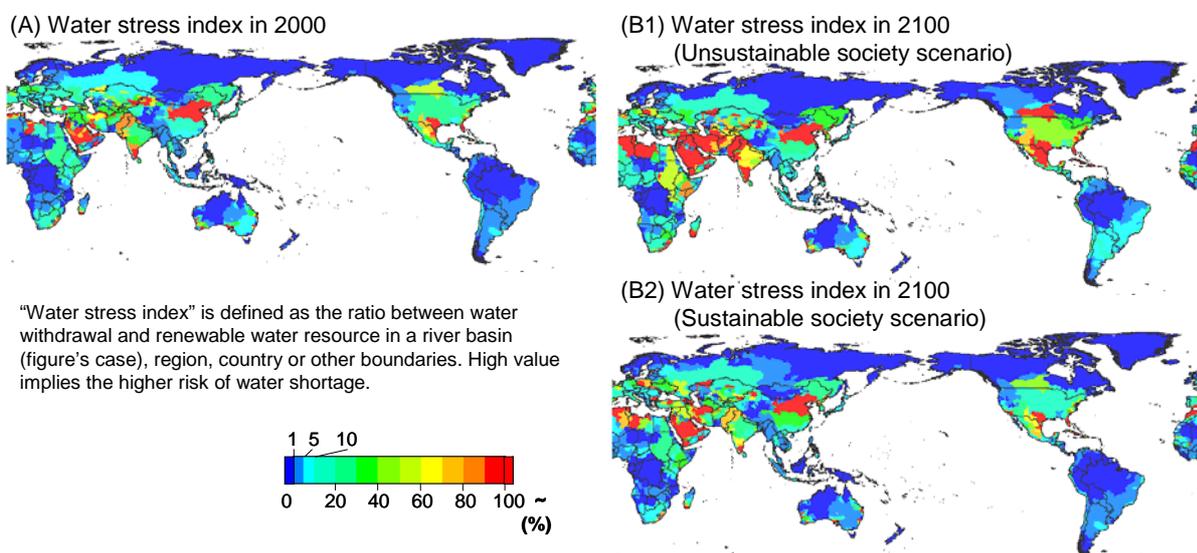


Fig. 4 Water stress index in 2000 and 2100[3]

3.2 Impact assessment considering adaptation measures

Importance of adaptation measures to mitigate negative impacts of climate change has been long recognized. However, quantitative evaluation of adaptation measures has not been conducted so much, especially at global scale. It is definitely an urgent research task. **Fig. 5** shows the potential productivity of wheat in 2000 and in 2050 estimated with AIM/Impact model. For estimating potential productivity in 2050, two alternative levels of adaptation were considered. In developing countries, negative impact of climate change might be compensated with the productivity increase derived from intensified irrigation and mechanization (Adaptation case). However, if adaptation measures are not taken appropriately, decrease in productivity will be significant (No adaptation case).

4. Future Research Needs

In impact and risk studies, a wide range of research is needed, including detection of emerging impacts, impacts on individual sectors, nationwide assessments, identification of threshold of impacts and vulnerable areas, and adaptation strategy and measures. Many of the studies to date focused on fundamental aspects such as methods of predicting impact. However, to tie these with countermeasures against global warming, we need clear answers to the following questions.

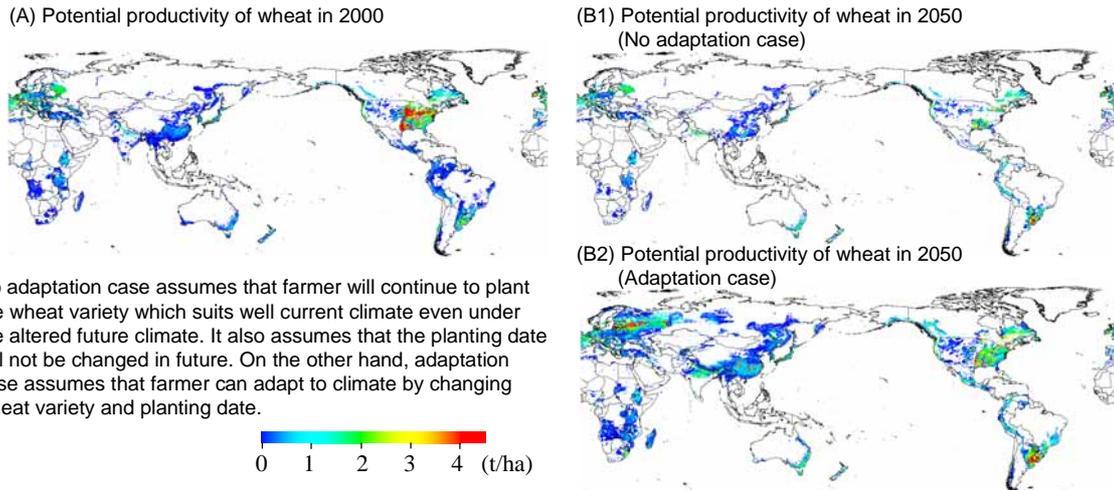


Fig. 5 Potential productivity of wheat in 2000 and 2050

- What extent (e.g., number of people at risk and monetary amount to be lost) will these impacts reach on a national scale?
- Which sectors in which regions will sustain the severest impacts?
- Threshold of impacts - How many degrees can the surface temperature rise and how many centimeters can sea levels rise before the world will have intolerable impacts?
- When will these occur?

Table 1 Threshold of Impacts [1]

Vulnerable Sector	Exposure System	Threshold
Ecosystem	Plants in High mountain Mangrove	Apparent effects for 2°C increase Cannot survive for 45cm SLR
Agriculture	Rice	Heat effect by over 35°C during flowering
Marine Ecosystem	Coral reef	Bleaching by 1-2°C increase in water temperature
Coastal Zone	Sandy beach Port and coastal structure	Erosion of 56.6% and 90.3% of sandy beaches by 30cm and 1.0m SLR 100 billion US\$ for countermeasures against 1m sea-level rise
Human Health	Elder people	Increase of mortality rate for over 33-35°C of daily high temp.(regional dependence)
Economy	Nations Electricity	Negative effects for 2-3°C increase Demand increase of 5000MW for 1°C increase in summer

Table 1 summarizes our current understanding of the critical values for impacts. Although we have obtained certain amounts of information, our knowledge remains insufficient to answer the fundamental questions above. Measures against warming can be classified as either measures to mitigate global warming or those to adapt to a warmer world. Large efforts are clearly needed to prevent warming;

however, we must also investigate adaptive measures to eliminate the deleterious effects of warming, as we cannot completely prevent warming by the current institutional and technical countermeasures.

References

- [1] Ichikawa, A. eds., 2004: Global Warming – The Research Challenges A Report of Japan's Global Warming Initiative, Springer, 160p.
- [2] Tanaka, N. al., 2002: Sensitivity and future response of forests to global warming. Report of Global Environment Reserch Fund of the MOE (in Japanese).
- [3] Harasawa, H., et. al., 2003: 3. Potential Impacts of Global Climate Change, In: Kainuma, M., Y. Matsuoka, and T. Morita, eds, Climate Policy Assessment Asia-Pacific Integrated Modeling(402pp), Springer, 37-54.