【S-14】

Strategic Research on Global Mitigation and Local Adaptation to Climate Change

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To help construct a sustainable society using an integrated approach for mitigation and adaptation, we performed a quantitative assessment to determine how effectively and efficiently climate change issues could be solved maintaining a delicate balance between mitigation and adaptation under conditions of limited economic and human resources. The results were utilized to support climate change policy development as risk management.

In this project, an integrated approach to ecosystem-based mitigation and adaptation to climate change was developed. Through this integrated approach, we gained three new and important insights. Firstly, shallow coastal ecosystems were found to constitute a global carbon sink (about 5 billion tons-CO_2 per year). Due to increasing temperatures and rising sea levels in the future, the expanse and carbon balance of shallow coastal ecosystems will change. Based on this knowledge, Yokohama City has started to utilize cultivation of eelgrass beds as a carbon credit. Secondly, we estimated that coral-reef-forming capacity would follow sea level rise. On the other hand, it is possible that this capacity may not be able to follow sea level rise due to reduced expanse of coral habitation as a result of coral bleaching caused by rising sea temperatures. Third, we found that efforts toward climate stabilization inhibit damage to ecosystems. To restrict the temperature increase from climate change to 2 °C, it will be necessary to implement countermeasures through land use changes such as afforestation and cultivation of crops for biomass fuel. Such land use change may decrease wildlife habitation and reduce biodiversity. Yet we clarified that keeping the temperature increase to 2 °C would be effective at stopping damage to ecosystems, even considering the effects of land use change.

We undertook the challenge of analyzing the costs versus benefits of climate change adaptation globally. Our target sectors were water-related disasters, food production, human health, and coastal regions. These cover the majority of adaptation costs for climate change. We carried out the cost-benefit analysis of adaptation to climate change in the above sectors by global models. We also integrated ecosystem effects. To reduce additional damage from climate change to the current level, it will be necessary to invest an amount equivalent to 1.5 % of the global GDP every year under the worst-case scenario (RCP8.5/SSP3). We cannot eliminate the additional damage from climate change entirely due to the limits of adaptation, however, we can reduce the damage from climate change through adaptation, particularly in Africa and Asia where river flooding will increase, and in the tropical and low-latitude regions where crop production will be badly affected by high temperatures.

The most recent IPCC report, AR5, suggested that high risks from global climate change are concentrated in urbanized areas. The theme of our research was to conduct a case study on mitigation and adaptation to climate change in an Asian megacity. The city of focus was Jakarta, Indonesia, where rapid urban sprawl is expected to continue for the next several decades and multiple stresses involving water disasters, heat stress, and land subsidence are occurring. Firstly, we developed an urban geographic information database in high resolution in time and space globally. This enables the future climate to be predicted and analyzed in urban areas around the world. Using this database, we conducted evaluations and cost-benefit analyses of policies to reduce the risk of urban flooding through mitigation and adaptation, and also an urban health impact assessment and cost-benefit analysis with regard to mitigation and adaptation. While economic development will reduce the indirect impact of climate change, such as undernutrition, flood, and infectious disease, on the contrary, heat stress, as direct impact of climate change, is predicted to increase. Increased air-conditioner usage, however, can reduce heat stress from climate change. Using a life-cycle assessment, alleviating sleeping disorder is preferable even with increased production and usage of air-conditioners; that is, there is high possibility that air conditioners would provide a net benefit to society.

According to IPCC AR5, there is a need to implement an integrated, quantitative evaluation of climate change mitigation and adaptation policies. We estimated the costs of impacts and adaptation policies consistent with global GHG emissions. Estimated increases in the costs of damage from climate change at the end of the 21st century run from 0.8 - 6.6% with large uncertainties due to unknown GHG emissions and future socio-economic situations. As a result, it means that the factors which we human beings select will have huge impacts on damage from climate change. The difficulty with climate change countermeasures is their strong dependence on the state of future societies, such as population, economy, advanced energy techniques, humanity's environmental awareness, and lifestyles. To minimize damage from climate change, not only the GHG reduction but also comprehensive societal changes will be necessary.

Finally, the economic damage, health damage by disability-adjusted life years (DALY), ecosystem damage by EINES (Expected Increase in Number of Extinct Species), and mitigation costs are integrated in terms of financial burden. The total cost of climate change is estimated at about US$450 - 800 trillion (about 3 - 7 % of the GDP). This is the world's first estimation of global adaptation costs. In the case of AIM and LCA, cutting-edge results have been organized including sectors which had never been considered so far. This information is precious knowledge for discussing which world we will choose.

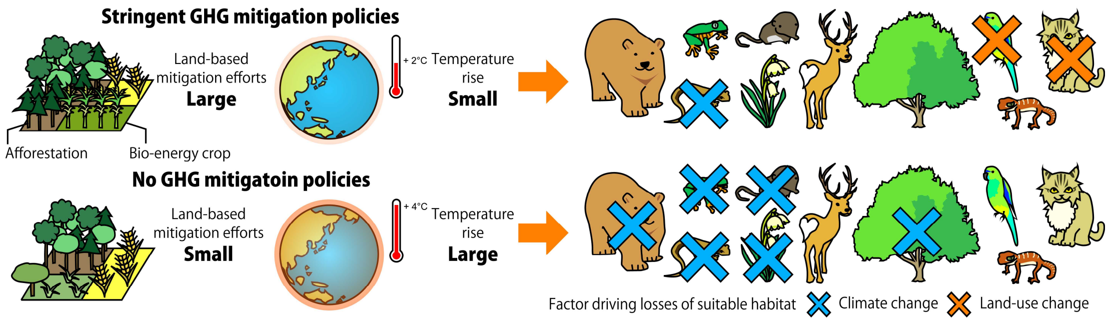

Fig. 1 This study compared future biodiversity loss with and without mitigation measures. The results show that a mitigation scenario in which the temperature increase is kept below 2°C (top) is expected to result in less biodiversity loss than a scenario without mitigation measures (bottom), in which many species lose their habitats due to significant temperature increases. (Ohashi et al., 2019)

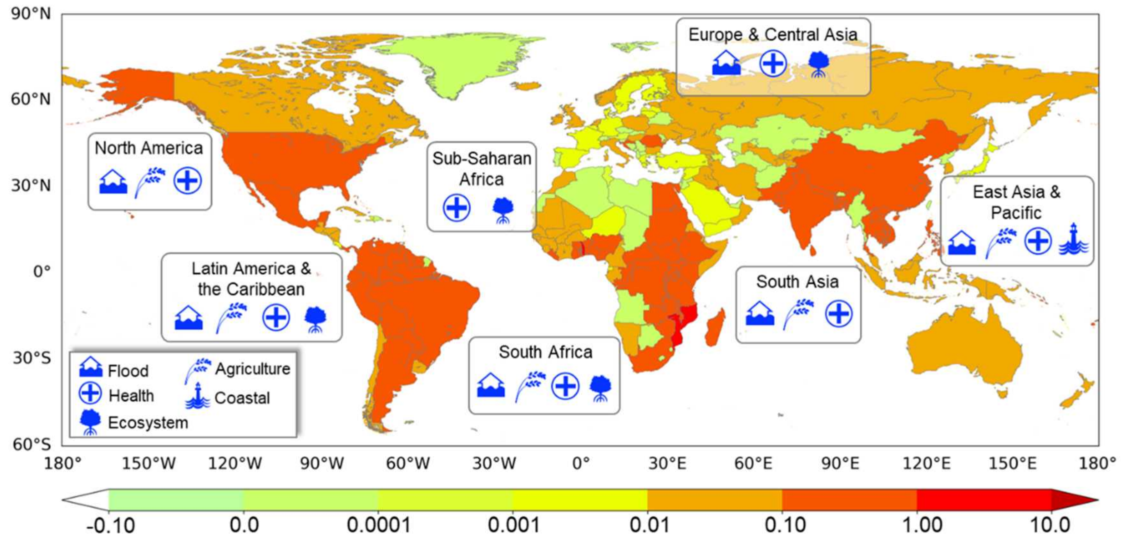

Fig. 2 Global cost of climate change (total cost of adaptation and residual damage after adaptation) in river flooding, crop production and coastal flooding as a proportion of the national administrative GDP. The results of the RCP8.5/SSP3 scenario are shown. Marks indicate sectors with high impacts from climate change.

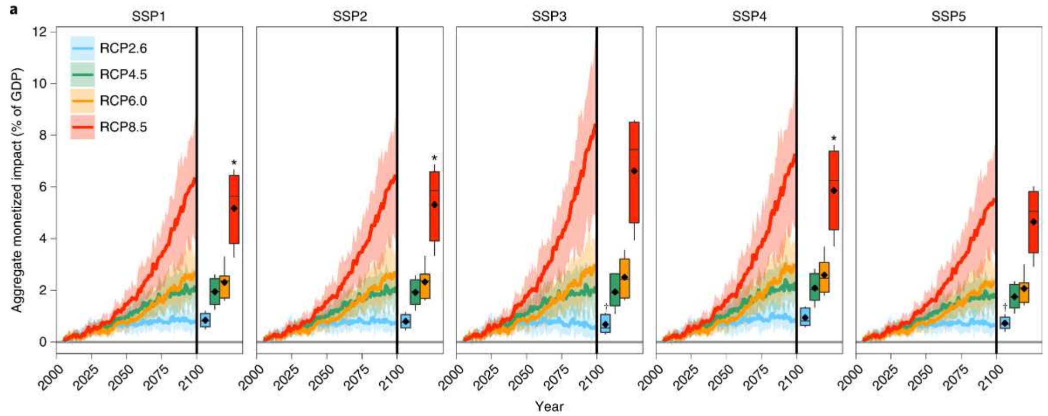

Fig. 3 Time series of aggregate monetized impacts and mean impact for 2080-2099. (Takakura et al., 2019).

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