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Policy Recommendations for a Sustainable Global Society Using AI
Analysis and Prospects by Future Scenario Simulator

Today's global society is facing unprecedented crises, such as climate change, ecosystem degradation, widening and fragmentation of economic disparities, and frequent conflicts and wars, and discussions on "planetary boundaries" regarding the finiteness of the global environment are becoming more active.

Under these circumstances, Kyoto University (Professor Yoshinori Hiroi) and Hitachi Kyoto University Laboratory (Hitachi Future Issues Exploration Joint Research Division) have jointly developed technologies for future simulations and policy proposals (policy proposal AI or future scenario simulators) using AI, and came up with Policy Recommendations for a Sustainable Future of Japan" (September 2017).[i] This technology has been used in future simulations and policy formulation in various local governments[ii].

Kyoto University and Hitachi, Ltd. have conducted joint research on new future simulations and policy proposals for the sustainability of the global society, which faces many difficult issues as described above, as a "global version" of policy proposal AI.

１. [Methods] We extracted 294 indicators related to the present and future of the global society based on relevant reports and databases of international organizations, created a causal linkage model consisting of them, conducted 20,000 simulations for 2050 using policy proposal AI (Future Scenario Simulator) technology, and analyzed the results.

２. [Simulation Results] It was shown that the future of the global society will be divided into the following seven scenarios (possible states of the global society) toward 2050.

(1) Scenarios that demonstrate relatively good performance in multiple aspects such as environmental, economic, social, and international conflicts

- Regional Dispersion and Maturity Scenario (Scenario 1)
- Green Growth and Cooperation Scenario (Scenario 2)

(2) Scenarios that have complex characters of positive and negative aspects

- Well-being and Lack of Environmental Consideration Scenario (Scenario 4)
- Economic Growth Supremacy Scenario (Scenario 6)

(3) Scenarios that show catastrophic situations such as climate crises, conflicts, and divisions between developed and developing countries

- Climate and Conflict Double Crisis Scenario (Scenarios 3 and 5)
- Polarization Scenario (Scenario 7)

In this way, it can be said that global society has the potential to reach "diverse futures" that are very different from each other toward 2050 (see Figure).

Figure: Future Scenarios and Branching Structures of Global Society

3 [Branching Patterns of Future Scenarios] Of these seven scenarios, the three scenarios that show relatively good performance in terms of the global environment such as CO2 emissions and global warming are the "Regional Dispersion and Maturity Scenario" (Scenario 1), the "Green Growth and Cooperation Scenario" (Scenario 2), and the "Polarization Scenario" (Scenario 7). Related divergences were shown to occur relatively early, up to around 2034. That is,

(1) The first bifurcation will be around 2029, at which time the "Polarization Scenario" (Scenario 7) and the other scenarios will diverge. The "Polarization Scenario" is favorable in terms of the environmental performance of the global level, but it is not desirable for the global society as a whole, as it is a scenario in which developing countries are left behind in economic development and large disparities or divisions arise between the developing countries and developed countries —in other words, developed countries monopolize a major part of the global resources and environment.

In order to avoid this polarized scenario, it is important for developed countries to promptly take environmentally oriented measures, such as reducing fossil fuel consumption and per capita energy consumption, and to actively take measures to promote economic developments in developing countries, such as increasing GDP per capita and improving social infrastructure in developing countries.

(2) The next branch will be around 2032, at which time the "Regional Dispersion and Maturity Scenario" (Scenario 1) and the other scenarios will diverge.
The "Regional Dispersion and Maturity Scenario" is a scenario in which growth slows on the economic front, but at the same time shows the best performance in terms of the environment, such as global CO2 emissions (along with Scenarios 2 and 7), and at the same time the international conflict decreases particularly significantly among all scenarios. Although social issues remain, the international disparity between developed and developing countries is decreasing, and as a whole, each

region of the globe is in the direction of achieving an "autonomous and decentralized" equilibrium and peace, which is considered to be one of the most promising future images.
In order to advance to this scenario, it was shown that social policy responses, including measures to address the declining birthrate and reduce inequalities in developed countries, research investment, population control, and improvement of access to healthcare in developing countries, are particularly important.

(3) The third branch will be around 2034, at which time the "Green Growth and Cooperative Scenario" (Scenario 2) and other branches will diverge.

The Green Growth and Cooperation Scenario is a relatively favorable scenario in which both developed and developing countries maintain economic development, global CO2 emissions decrease, and international disparities between developed and developing countries (as in Scenario 1) decrease. However, there are still challenges, such as widening inequalities at the domestic level in developed countries and a slight decrease in international conflicts.

In order to move toward this "Green Growth and Cooperation Scenario," the simulation showed that in addition to improving labor productivity, public and infrastructure investment, and research investment in developing countries, social capital (cooperativeness) in the world as a whole, that is, cooperative awareness and behavior at the international level, is extremely important.

(4) After the above branching, it was shown that further divergence will occur around 2038, 2046, and 2047, and the remaining scenarios will be derived.

- "Economic Growth Supremacy Scenario" (Scenario 6): A scenario in which both developed and developing countries achieve high economic growth, but the environment deteriorates, such as the largest increase in global CO2 emissions, and the well-being of developed countries is also poor.
- "Climate and Conflict Double Crisis Scenario" (Scenarios 3 and 5): A scenario in which developed countries achieve low growth while developing countries achieve high economic growth, but conflicts intensify and environmental crises are simultaneously occurring over finite resources and the environment.
- " Well-being and Lack of Environmental Consideration Scenario" (Scenario 4): A scenario in which people's well-being increases while the economy matures, but environmental degradation progresses on a global level.

None of these seem to be desirable future images.

4. [Evaluations and Discussions] The following understanding can be made by comparing the "Regional Dispersion and Maturity Scenario" (Scenario 1) and the "Green Growth and Cooperation Scenario" (Scenario 2), which are considered to represent a relatively desirable future image of the global society among all scenarios.

The "Green Growth and Cooperation Scenario" (Scenario 2) is a scenario in which economic globalization progresses further along with a certain level of

environmental consideration, and while the economy performs relatively well in terms of the relationship with the environment, issues such as inequalities within developed countries and international conflicts remain. And for this reason, the "global social capital," or cooperative action at the international level which is mentioned above, is particularly key.

On the other hand, in the "Regional Dispersion and Maturity Scenario" (Scenario 1), the expansion of the global economy does not progress as in Scenario 2, but rather the maturation of the economy is endorsed, and each region of the globe is dispersed to achieve a certain degree of autonomous equilibrium, environmental conservation, peace and well-being. It can be said that it is a vision of the future of the global society that emphasizes "localization," that is, economic circulation and sustainability at the local and regional levels, while building up national and global.

Whether the "Green Growth and Cooperation Scenario" or the "Regional Dispersion and Maturity Scenario" is desirable depends on which policy issues or values are prioritized and what kind of social image is considered desirable, and it is not a character that can be drawn unambiguously.

５. [Challenges and Prospects] It can be said that this research is an AI version of "The Limits to Growth" (1972), which was published by the Club of Rome and warned about the finite nature of the earth's resources through simulations using the latest computer technology at the time.

"The Limits to Growth" was basically focused on aspects related to resources and energy, but this simulation also takes into account more pluralistic and contemporary factors such as global warming, the economy and inequality, the relationship between developed and developing countries, and social aspects including well-being. On the other hand, there are still issues in this simulation in terms of data collection and model formulation methods, and we will strive to further improve it in the future.

In any case, it is important to conduct quantitative simulations of the future of global society using technologies such as AI in the form shown in this study, and to proceed with discussions on the future image that should be realized and the measures that should be taken.

Based on the results of this simulation, it is shown that the significant divergences regarding the future of the environment at the global level and whether or not to move toward a desirable future will occur as early as around 2034, and immediate action is required.

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[i] Kyoto University and Hitachi, Ltd., "Proposing Policies for a Sustainable Future of Japan through the Utilization of AI: Aiming to Use AI for Strategic Policy-Making by the National and Local Governments," September 5, 2017.

[ii] Nagano Prefecture, Hyogo Prefecture, Takahama City, Fukuyama City, Yamaguchi City, etc. (The contents of the simulation are published on the websites of each municipality).