

## Co-design trial: Case of climate engineering (geoengineering)

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The global sustainability research program, Future Earth, aims to pursue transdisciplinary research, by conducting projects in collaboration with stakeholders and integrate necessary knowledge across disciplines (natural sciences, social sciences, and humanities). Here we report the progress of a feasibility study under the auspices of the Future Earth activities supported by JST RISTEX.

Climate engineering (CE) or geoengineering refers to a set of proposals that are aimed at intervening in the climate system to counteract effects of global warming. It covers a broad range of proposals, which can be categorized into solar radiation management (SRM) and carbon dioxide removal (CDR) (Royal Society 2009; National Research Council 2015). Among many proposals, stratospheric aerosol injection (SAI), an SRM method, is receiving the most attention. It mimics the mechanism of global cooling after a major volcanic eruption and artificially sprays aerosols into the stratosphere, thereby increasing the planetary albedo. The climate science community is paying attention to CE, and the model intercomparison project on CE, GeoMIP6, is one of the endorsed projects under CMIP6, which is underway in preparation for IPCC AR6.

There are many controversies with CE, and it is desirable to reflect interests and concerns of the public and stakeholders in research directions. The transdisciplinary approach is thus essential for CE research, and it should start from the very early stage of research. In other words, responsible innovation is a necessity.

Looking at the past research projects, nevertheless, reveals a problematic situation. Although the literature contains many interdisciplinary projects and public engagement, research questions have been often framed by scientists; stakeholders join projects only after the projects start. To improve this situation, we co-designed a research agenda in collaboration with stakeholders..

Methodologically we adopted the workshop for creating a research agenda developed by Sutherland et al. (2011). We held our workshop on July 26, 2015, at the Hongo Campus of the University of Tokyo. About 20 researchers and approx. 20 stakeholders (policymakers, industry, environmental NGOs, media, etc.) took part in the workshop. This group covers major interests in the climate debate in Japan. We gathered 600 research questions from the participants before the workshop, during which we reduced to 40 questions. The resulting 40 questions can be grouped into the following categories. They include a number of interdisciplinary questions, reflecting diverse interests of stakeholders.

- (1) Social and economic assessment: costs, benefits, and non-economic values
- (2) (Negative) side effects: risk, uncertainty, and policy response
- (3) Prediction, attribution, observation and technological controllability
- (4) Policy approaches in broader climate risk management: mitigation, adaptation, and emergency response
- (5) Field test and technology development: technical design and socio-political framework
- (6) Governance of implementation: legal, political and ethical challenges
- (7) Social and political implications: gender, communication, and Japan's role

Based on some of these questions, we are now conducting Phase 2 of our research project.

Without doubt, the whole process contributed to mutual learning between scientists and stakeholders. Our next step is to reflexively examine the process and explore possibilities and limitations of the workshop method.

#### REFERENCES

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