

OPEN ACCESS

EDITED BY

Tomoyo Toyota,
University of Shimane, Japan

REVIEWED BY

Edward Morgan,
Griffith University, Australia
Herman Kasper Gilissen,
Utrecht University, Netherlands

*CORRESPONDENCE

Masako Ichihara
✉ ichiharamasako@chikyu.ac.jp

RECEIVED 30 September 2023

ACCEPTED 28 December 2023

PUBLISHED 05 February 2024

CITATION

Ichihara M, Nakagawa Y, Ishii R, Saijo T and Yasunari T (2024) Toward a transformative climate change adaptation from local to global perspective—A transdisciplinary challenge by Kyoto Climate Change Adaptation Center. *Front. Clim.* 5:1304989. doi: 10.3389/fclim.2023.1304989

COPYRIGHT

© 2024 Ichihara, Nakagawa, Ishii, Saijo and Yasunari. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Toward a transformative climate change adaptation from local to global perspective— A transdisciplinary challenge by Kyoto Climate Change Adaptation Center

Masako Ichihara^{1*}, Yoshinori Nakagawa^{1,2}, Reiichiro Ishii¹,
Tatsuyoshi Saijo^{1,3} and Tetsuzo Yasunari¹

¹Kyoto Climate Change Adaptation Center, Research Institute for Humanity and Nature, Kyoto, Japan,

²Graduate School of Global Environmental Studies, Sophia University, Tokyo, Japan, ³Institute for International Academic Research, Kyoto University of Advanced Science, Kyoto, Japan

Policies for climate change adaptation differ from those for climate change mitigation, both of which share the common aim of maintaining a sustainable climate system that enables humankind to survive while enjoying wellbeing. Considering the variability in regional conditions, they must be diverse throughout the policymaking process, with the participation of multiple stakeholders, to place the livelihood of residents as the central issue. Simultaneously, these regional diversities must also be realized in a manner consistent with the global goal of climate change mitigation. To that end, comprehensive and transformative adaptation measures are essential, rather than responding to imminent issues on an *ad-hoc* basis. As the literature shows, a transdisciplinary approach involving researchers across different fields and multiple non-academic sectors can fill the gaps in transformative adaptation. Still, it has yet to be implemented because of the lack of experience of this issue. Here, we present key findings that affect the generation of synergies and tradeoffs among issues through our novel transdisciplinary approach in Kyoto, Japan, via a series of Future Design workshops in agriculture in collaboration with local farmers, regional policymakers, and researchers with diverse backgrounds. These results provide a direction for future research to secure a methodological foundation that will facilitate the sustainability of these efforts.

KEYWORDS

transformative climate change adaptation, transdisciplinary approach, Future Design, agricultural sector, adaptation policies in local communities, policy integration, codesign workshops, Japanese local climate adaptation policy in Kyoto

1 Introduction

1.1 Background

The accelerated severity and magnitude of climate change have increased the global need for urgent adaptation measures. Climate change adaptation refers to “adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects” (UNFCCC, 2023a).

As of 2023, 85% of countries will have at least one national adaptation planning instrument (ibid.). In addition, 25% have legal instruments that require

national governments to prepare national adaptation-planning instruments. However, adaptation measures are often limited to coping or incremental strategies. Such conventional adaptation measures generally focus on solutions at a limited regional scale, which unintentionally causes negative impacts in other areas. Consequently, such implementations have often resulted in maladaptation, which may lead to an increased risk of adverse climate-related outcomes, including increased vulnerability to climate change, diminished welfare, and increased GHG emissions (Fedele et al., 2019; IPCC, 2022).

Countermeasures that consider long-term and more fundamental perspectives are required to identify climate-resilient development (CRD), which is compatible with global-scale mitigation measures for climate change. The accumulation of maladaptation cases worldwide has led to the development of the concept of CRD to direct adequate adaptation (Klein et al., 2007). Specifically, the need for more appropriate transformative adaptation (TA), including responses that address society's vulnerabilities instead of immediate *ad-hoc* responses, can provide a fundamental solution. In this regard, various transborder effects on the global environment encompassing the entire region through the exchange of people and goods should be considered (Mark, 2010; Zolnikov, 2019; IPCC, 2022).

Contrary to mitigation, conventional adaptation policies rely primarily on accumulating natural scientific knowledge and insights that provide prospects for climatic conditions, downscaling global climate prediction [United Kingdom (UK), 2008; Japan, 2018; France, 2023; South Korea, 2023]. To date, human and social aspects have not been sufficiently considered, although the lives of residents, main stakeholders, and those most closely affected by future policies are the most important factors to be considered (IPCC, 2022). This requirement can also be seen in the definition of climate adaptation mentioned above, which does not designate any specific actions because adaptation should be pursued following each region's social-ecological conditions and characteristics. This sharply contrasts mitigation, globally defined as "Efforts to reduce emissions and enhance sinks" (UNFCCC, 2023b).

In this context, the involvement of various stakeholders, including residents, in the decision-making process of adaptation measures is crucial (Cattino and Reckien, 2021; IPCC, 2022). Moreover, because adaptation measures will be implemented over a long period and are subject to various future uncertainties, adaptive management, or incorporating a management system into policies in advance of possible situations that were not initially anticipated, is essential (Mark, 2010).

The abovementioned requirements necessitate transdisciplinary (TD) approaches (Future Earth, 2023) that identify and generate the integrated knowledge needed for TA measures. Indeed, the TA has gradually been adopted, shifting from incremental ones (UNEP, 2023), although they are still insufficient to fulfill the requirements.

1.2 Previous research and its limitation

Numerous past practices and analyses have shown that TD requires careful design, dialogue, and consideration of the entire process to create effective synergies to achieve the initiative's

objectives. The key elements include the degree of prior stakeholder negotiation, institutional infrastructure, sustainability of funders and financial resources, ownership and awareness, clarity of administrative responsibilities, agreements among all stakeholders, and sufficient timescales for sustainably implementing a project (Lux et al., 2019; Newig et al., 2019).

Several TD approaches have been adopted as municipal climate change adaptation measures (Mark, 2010; Brink et al., 2018; Owen, 2020). A recent influential study by Wamsler (2017) comprehensively examines the stakeholder involvement process and its influence on outcomes. The study employed various analytical methods at each collaboration stage, identifying key elements crucial for the sustained engagement of stakeholders in a sustainable and transformative process and for effectively creating synergies reflected in the outcomes. Among these elements, one significant factor is establishing a governance structure that facilitates the ongoing participation of competent individuals. Another essential aspect is ensuring the participants' sense of ownership and shared goals throughout the process. Proper interlocking of these elements will ensure the proactive involvement of local stakeholders, unify top-down and bottom-up efforts, and create a holistic and decentralized governance system for TA. However, a pathway for this process has not yet been established.

1.3 Research objective

Based on this situation, it is now clear that the continued participation of various stakeholders is crucial. However, it remains quite challenging to realize this because we do not have an effective methodology, especially regarding how we can ensure the participants' sense of ownership and goal sharing in the entire TD process toward the TA.

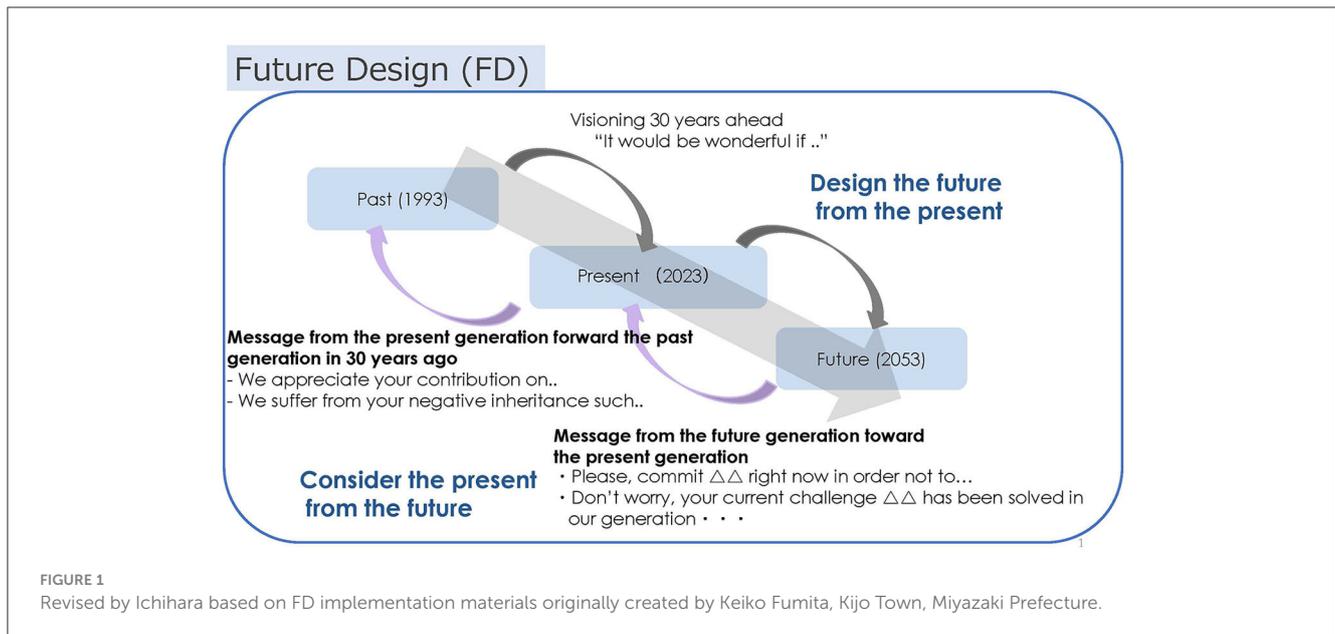
Therefore, this study investigates a possible methodology for achieving this objective based on our ongoing case study in the Kyoto region of Japan.

2 Methods

2.1 A case study at Kyoto Climate Change Adaptation Center (KCCAC)

Kyoto has been the capital of Japan for over 1,000 years and remained a significant center of Japanese culture even after Tokyo became the capital city in the nineteenth century. Agriculture has been practiced throughout present-day Kyoto Prefecture since ancient times. Rice cultivation will be dominant in the northern region which has been dominated for more than a thousand years or so (Ministry of Agriculture, Forestry and Fisheries, 2022).

As one of the Local Climate Change Adaptation Centers (LCCACs), the Kyoto Climate Change Adaptation Center (KCCAC) was jointly established in 2021 by Kyoto Prefecture, Kyoto City, and the Research Institute for Humanity and Nature (RIHN) [(Kyoto Climate Change Adaptation Center (KCCAC), 2023)]. The Climate Change Adaptation Act enacted in 2018, promotes the establishment of LCCAC, assigning discretion to local governments in determining its form and structure



[Ministry of Environment (MOE), 2018] (Figure 1). While many municipalities have LCCACs within their administrative departments (A-Plat: Climate Change Adaptation Platform, 2023), few centers have ancillary partnerships with research institutions. The KCCAC has a unique structure in the point that the government and academia operate jointly on an equal footing, which is a useful TD research platform.

2.2 Future design: a novel method with high potential

The Future Design method (FD; Saijo, 2020a) originates from economic mechanism design. It aims to develop a scheme that shifts people's thinking and behavior toward a future-oriented approach with a long-term perspective by reviewing ideas from several sciences, including behavioral and experimental economics. In FD, all participants are expected to be imaginary future persons (IFPs), envisioning an ideal future through discussions from the standpoint of that future, free from any conditions and limitations of present societies. This idea is underlined by the recognition of the innate human tendency to prioritize immediate benefits and shortsighted cognition, combined with the market and democratic systems that form the foundation of modern society. This combination has repeatedly led people to conduct "future failures" (Hara et al., 2019; Saijo, 2020b), in which the interests of the current generation are prioritized even at the expense of the benefits and peace of mind of the generations in the distant future.

To date, numerous FD experiments and practices have demonstrated that FD can avoid falling into the narrow-mindedness of focusing on solving single problems to overlook the possible negative impact on other challenges. It also allows people to reduce their current benefits to secure future benefits (Kamijo et al., 2017; Hara et al., 2019; Saijo, 2019, 2020a,b; Inoue et al., 2021, 2023; Shahen et al., 2021). Therefore, a fundamental

and comprehensive solution must be pursued. In addition, each person's creativity and originality can be fully exercised in that situation, in contrast to thinking about the future as an extension of the present. Thus, the FD made participants from various backgrounds share an objective and draw a common vision. This corresponds to the elements of a successful TA, as indicated in a previous study (Wamsler, 2017), indicating that FD has a strong potential for our objective.

Since FD was first proposed in 2012 (Saijo, 2020a), numerous studies have been conducted in Japan and other countries. Many of these practices have focused on single-issue, minor geographical themes such as comprehensive municipal planning, the intergenerational burden of water rates, and the management of community facilities. Participants were often brought together by the same or similar attributes, such as belonging to the same organization. Thus, there were no particular barriers to the continued participation of the same members. Also, the social status of the members was often similar, and discussions naturally took place on an equal footing.

3 Results

3.1 Current challenges in agriculture in Kyoto

So far, KCCAC conducted interviews with various sectors in Kyoto including public high schools, traditional culture, crafts, temples, shrines, gardens, institutions related to agriculture, forestry, and fisheries. Among the results, KCCAC selected the agriculture sector that urgently required adaptation countermeasures. The sector is qualitative to represent residents affected by climate change, as well as connoting many key issues in terms of the complex combination of climate change issues and local challenges.

Also, agriculture is a sector vulnerable to climate change. This vulnerability often stems from the negative direct impacts of climate change on harvests and its role as a social infrastructural sector. Indeed, agriculture is facing diverse challenges, including a decrease in successors, farmers' aging, and supply chain instability, and, therefore, urgently requires TA (Howden et al., 2007; UNEP, 2023).

Our interviews revealed that farmers' insufficient recognition of climate impacts, with little preparation, suffered from a severe shortage of workforce and an aging problem, which is consistent with a previous survey conducted in other Japanese regions (Tamura et al., 2021). Furthermore, many farmers are too occupied with their daily livelihoods to consider climate change countermeasures from a long-term, fundamental perspective and frequently adopt shortsighted solutions. Those conditions have often led them to "future failures," as mentioned in Section Future design: a novel method with high potential.

Since the stakeholders of the agricultural sector are not only farmers but also their surrounding networks in the supply chain and administration sectors, TD's approach to TA must include those networks. However, relevant methodologies cannot be found in the literature.

Therefore, general attempts to resolve these issues will inevitably lead to conflicts of interest among the various stakeholders, making it challenging to resolve them. This is the primary rationale for the KCCAC's decision to use FD to consider adaptation measures.

3.2 Unique and necessitated modification of the FD in the agricultural field

Most previous FDs have focused on a single issue, as mentioned in Section Future design: a novel method with high potential, with participants often brought together by the same or similar attributes, such as belonging to the same organization. In contrast, the FD at the KCCAC sought a TA that connotes cross-cutting issues to avoid maladaptation, as mentioned in Section Background. In addition, it is necessary to recruit participants from different fields, including agricultural professionals, government officials, and researchers.

Based on these requirements, the KCCAC has attempted two modifications. First, an opinion forum was established after each FD workshop to review outputs. To meet our objective to achieve TA, a feasible vision of the future must be drawn. However, when people from different fields work together to create a vision of the future, there is a risk that the scientific and objective basis of the vision may be inadequate because participants do not share similar knowledge. The forum scrutinized the feasibility and scientific implausibility of the drawn future visions to prepare a common basis for subsequent discussions. Thus, the KCCAC aims to create an original vision incorporating cross-cutting issues. Second, careful care was taken to ensure that participants could engage in discussions on an equal footing. Researchers tend to behave haughtily because of the social responsibility they owe to scientifically accurate and authentic academic expressions. To avoid intimidating other participants with these tendencies,

the KCCAC asked researchers for particular awareness of an equal footing.

3.3 Some preliminary outputs

To date, the KCCAC has conducted two FD workshops and opinion forums. Five farmers, 12 researchers, and 3–5 government officials participated in the project. Several groups were established, each consisting of three members, with one from each field. The members, as IFPs, discussed the state of agriculture in Kyoto as of 2053 down to specific details in the context of noticeable climate change impacts. After each FD workshop, the KCCAC held an opinion forum on the participation of all members of the FD project, including those who did not participate in the workshops.

Thus far, the generated future ideas mostly connote creativity and are comprehensive as the fruit of discussions among diverse stakeholders equally based on their expertise. Examples of the generated ideas are as follows: The installation of AI technology and further development of factory farming in agriculture to avoid the adverse effects of climate impacts on harvests will simultaneously increase knowledge work in agriculture. Consequently, the skills required for farmers, such as computing operations and data management, will become more versatile, increasing the number of workers. Consequently, more young people have become involved in agriculture, which was not initially intended for AI installation. Another idea discussed by several groups was that as the population of Japan declines and ages, the social status of the agricultural sector improves because of the relative decline in international competitiveness and the need to invest in national resources to ensure food security. Here, ideas were created in which the often negatively evaluated phenomenon of population decline had two positive effects: improving the status of agriculture and ensuring food security.

These results demonstrate how cross-cutting solutions were found. Further discussion is required to examine how such emerging results lead to TA. In this sense, the potential of FD as an effective method for achieving TA is evident.

Another result was a change in the participants' attitudes. At the end of each FD practice, many participants became more willing to participate in subsequent practices, suggesting that multiple stakeholders are now willing to transcend their positions, look beyond their current interests and ties to the distant future, and enjoy working together to create an ideal vision for the future with ownership, which is one of the key components in achieving transformative adaptation, as mentioned in Section Previous research and its limitation. This is another example of how the transformative approach was used in the past. This was a problematic issue to overcome in the past for TA and TD.

4 Discussion

4.1 Factors that supported the outcomes

Full support from the Kyoto Prefectural Administration in ensuring participants with FD through its broad network is critical for the implementation of this project. Because researchers

generally have no access to farmers, the KCCAC gained access to farmers with the assistance of regional and local administrative branches in the agricultural sector. A crucial motivation for joining this project may be that the KCCAC, including the Kyoto Prefectural Administration, allows participating farmers to deliver their opinions directly to administrative organizations. One of the reasons these farmers took time to participate in the workshop may be the motivation mentioned above. This governance structure is another crucial component, as mentioned in Section Previous research and its limitation. Indeed, a participating farmer expressed that help from the administrative organization was indispensable for maintaining good relations with the local community and managing a self-sustaining agricultural facility.

4.2 Some remaining issues for the future

First, the continuous participation of the administrative sector was challenging for all three stakeholder groups participating in the FD project. In general, Japanese administrative jurisdiction is defined in detail in a sectoral manner, and involvement in other tasks is positioned as something that should be done only on a secondary basis and within the scope of not intervening in routine. Furthermore, formal administrative staff in Japan, including those in Kyoto, are usually transferred every 2 or 3 years. In the FD, although it should be appropriate for administrative staff in agricultural or forestry departments to participate in projects on the topic of climate change adaptation in agriculture, some vertically segmented conflict may occur in the initiative role between other sectors, such as the environmental department.

The second question was how participants with FD were selected. Currently, the participants are volunteers who responded to the KCCAC's call, but selecting the best people from each sector, in line with the themes to be discussed at the FD, is a major issue for the future. Of course, as we learned in this FD, raising awareness of TA among participants is also crucial.

4.3 Implications for other regions as a TA method

FD is a new method that can potentially foster transformative adaptations that can be used worldwide. The basic concepts of FD are simple, as described in Section A case study at Kyoto Climate Change Adaptation Center (KCCAC), and can be easily implemented in other regions. Moreover, modifying the FD at the KCCAC as a method for transformative adaptation to climate change, as described in Section Future design: a novel method with high potential, is only a preliminary attempt. There is room for each region to examine other trials that consider regional characteristics of climate adaptation. Suppose transformative adaptation using FD spreads to other regions through these efforts. In that case, the problem of negative external impacts on other regions in realizing adaptation in one region, which was an aspect of maladaptation in the past, can also be improved through the implementation in cross-broader regions.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The research was approved by the ethics committee of the music department at Bar-Ilan University (Approval no. B.MUS.2016-5). All participants signed informed consent forms before participating in the project.

Author contributions

MI: Investigation, Conceptualization, Funding acquisition, Project administration, Visualization, Writing—original draft. YN: Conceptualization, Methodology, Resources, Writing—review & editing. RI: Investigation, Conceptualization, Funding acquisition, Writing—review & editing. TS: Conceptualization, Methodology, Resources, Writing—review & editing. TY: Conceptualization, Supervision, Funding acquisition, Writing—review & editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. National and municipal expenditures of Kyoto Prefecture and Kyoto City supported this study. MI was supported by KAKENHI-PROJECT-23KJ2161.

Acknowledgments

We thank the KCCAC members from Kyoto Prefecture and Kyoto City for their sincere collaboration. We also truly appreciate all the participants in the FD project.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

- A-Plat: Climate Change Adaptation Platform (2023). *Local Climate Change Adaptation Center*. Available online at: <https://adaptation-platform.nies.go.jp/en/> (accessed September, 2023).
- Brink, E., Wamsler, C., Adolfsson, M., Axelsson, M., Beery, T., Björn, H., et al. (2018). On the road to 'research municipalities': analyzing transdisciplinarity in municipal ecosystem services and adaptation planning. *Sustain. Sci.* 13, 765–784. doi: 10.1007/s11625-017-0499-0
- Cattino, M., and Reckien, D. (2021). Does public participation lead to more ambitious and transformative local climate change planning? *Curr. Opin. Environ. Sustain.* 52, 100–110. doi: 10.1016/j.cosust.2021.08.004
- Fedele, G., Donatti, C. I., Harvey, C. A., Hannah, L., and Hole, D. G. (2019). Transformative adaptation to climate change for sustainable social-ecological systems. *Environ. Sci. Policy* 101, 116–125. doi: 10.1016/j.envsci.2019.07.001
- France (2023). *Code de l'environnement*. Available online at: https://www.legifrance.gouv.fr/codes/texte_lc/LEGITEXT000006074220/2023-09-29/ (accessed September, 2023).
- Future Earth (2023). *Our Work*. Available online at: <https://futureearth.org/about/our-work/> (accessed September, 2023).
- Hara, K., Yoshioka, R., Kuroda, M., Kurimoto, S., and Saijo, T. (2019). Reconciling intergenerational conflicts with imaginary future generations - evidence from a participatory deliberation practice in a municipality in Japan -. *Sustain. Sci.* 14, 1605–1619. doi: 10.1007/s11625-019-00684-x
- Howden, S. M., Soussana, J. F., Tubiello, F. N., Chhetri, N., Dunlop, M., and Meinke, H. (2007). Adapting agriculture to climate change. *Proc. Natl. Acad. Sci. U.S.A.* 104, 19691–19696. doi: 10.1073/pnas.0701890104
- Inoue, Y., Himichi, T., Mifune, N., and Saijo, T. (2021). People prefer joint outcome prosocial resource distribution towards future others. *Sci. Rep.* 11:5373. doi: 10.1038/s41598-021-84796-4
- Inoue, Y., Mifune, N., and Saijo, T. (2023). Positive reputation for altruism toward future generations regardless of the cost for current others. *Front. Psychol.* 13:8668. doi: 10.3389/fpsyg.2022.895619
- IPCC (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability. Working Group II Contribution to the IPCC Sixth Assessment Report*. IPCC.
- Japan (2018). *Climate Change Adaptation Act*. Available online at: <https://www.japaneselawtranslation.go.jp/ja/laws/view/3212> (accessed September, 2023).
- Kamijo, Y., Komiya, A., Mifune, N., and Saijo, T. (2017). Negotiating with the future: incorporating imaginary future generations into negotiations. *Sustain. Sci.* 12, 409–420. doi: 10.1007/s11625-016-0419-8
- Klein, R. J. T., Huq, S., Denton, F., Downing, T. E., Richels, R. G., Robinson, J. B., et al. (2007). "Inter-relationships between adaptation and mitigation. Climate change 2007: impacts, adaptation and vulnerability," in *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK: Cambridge University Press), 745–777.
- Kyoto Climate Change Adaptation Center (KCCAC) (2023). Home. Available online at: <https://kccac.jp/> (accessed September, 2023).
- Lux, A., Schäferb, M., Bergmanna, M., Jahn, T., Marg, O., Nagy, E., et al. (2019). Societal effects of transdisciplinary sustainability research—How can they be strengthened during the research process? *Environ. Sci. Policy* 101, 183–191. doi: 10.1016/j.envsci.2019.08.012
- Mark, P. (2010). *Adaptation to Climate Change: From Resilience to Transformation*. London: Routledge.
- Ministry of Agriculture, Forestry and Fisheries (MAFF) (2022). *Overview of Agriculture, Forestry and Fisheries in Kyoto*. Ministry of Agriculture, Forestry and Fisheries (MAFF) Available online at: https://www.maff.go.jp/j/kanbo/tiho/attach/pdf/todouhukun_gaiyou2022-26.pdf (accessed September, 2023).
- Ministry of Environment (MOE) (2018). *Commentary of Climate Change Adaptation Act (CCAA, Act No. 50 of 2018)*. Ministry of Environment (MOE) Available online at: <https://www.env.go.jp/content/900449823.pdf>
- Newig, J., Jahn, S., Lang, D. J., Kahle, J., and Bergmann, M. (2019). Linking modes of research to their scientific and societal outcomes. Evidence from 81 sustainability-oriented research projects. *Environ. Sci. Policy* 101, 147–155. doi: 10.1016/j.envsci.2019.08.008
- Owen, G. (2020). What makes climate change adaptation effective? A systematic review of the literature. *Glob. Environ. Change* 62:102071. doi: 10.1016/j.gloenvcha.2020.102071
- Saijo, T. (2019). "Future design," in *Future of Economic Design: The Continuing Development of Field as Envisioned by Its Researchers*, eds L. Moulin and M. Sanver (Springer Nature), 253–260. doi: 10.1007/978-3-030-18050-8_35
- Saijo, T. (2020a). Future design: bequeathing sustainable natural environments and sustainable societies to future generations. *Sustainability* 12:6467. doi: 10.3390/su12166467
- Saijo, T. (2020b). "Future design", in *Future Design: Incorporating Preferences of Future Generations for Sustainability*, ed S. Tatsuyoshi (Singapore: Springer Nature). 1–16. doi: 10.1007/978-981-15-5407-0
- Shahen, M. E., Kotani, K., and Saijo, T. (2021). Intergenerational sustainability is enhanced by taking the perspective of future generations. *Sci. Rep.* 11:2437. doi: 10.1038/s41598-021-81835-y
- South Korea (2023). *Korea's effort to address climate change*. Available online at: https://www.mofa.go.kr/eng/wpge/m_5655/contents.do (accessed September, 2023).
- Tamura, M., Uchiyama, H., and Imai, Y. (2021). Climate change impacts and adaptations in the agricultural sector 2020 survey of farmers' perceptions in cities and towns, Ibaraki. *Proc. Jpn. Soc. Civil Eng.* 77, 221–229. doi: 10.2208/jscej.77.5_1_221
- UNEP (2023). *Adaptation Gap Report 2023*. UNEP.
- UNFCCC (2023a). *Introduction*. UNFCCC. Available online at: <https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/introduction> (accessed September, 2023).
- UNFCCC (2023b). *Introduction to Mitigation*. UNFCCC. Available online at: <https://unfccc.int/topics/introduction-to-mitigation> (accessed September, 2023).
- United Kingdom (UK) (2008). *Climate Change Act 2008*. Available online at: <https://www.legislation.gov.uk/ukpga/2008/27/contents> (accessed September, 2023).
- Wamsler, C. (2017). Stakeholder involvement in strategic adaptation planning: transdisciplinarity and co-production at stake? *Environ. Sci. Policy* 75, 148–157. doi: 10.1016/j.envsci.2017.03.016
- Zolnikov, T. R. (2019). *Global Adaptation and Resilience to Climate Change*. Cham: Palgrave Macmillan. doi: 10.1007/978-3-030-01213-7