Chapter 1

Climate Change Risk and Adaptation

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1.1 The Impacts of Climate Change in East and Southeast Asia

Climate change is considered by many to be the most critical issue of our time, posing a threat to security and socio-economic prosperity at the global level (MFAJ 2017). Asia is very vulnerable to the impacts of climate change, as more than 60% (approximately 4.5 billion) of the world's people live in the region, making it a growth center of the world (UNDESA 2017).

In 2017, human-induced global warming reached approximately 1 °C (between 0.8 °C and 1.2 °C) above pre-industrial levels, increasing at a rate of 0.2 °C (likely between 0.1 °C and 0.3 °C) per decade (Fig. 1.1; IPCC 2018). Figure 1.2 shows projected temperature changes in Southeast Asia, as calculated by Japan's Ministry of the Environment and the Japan Meteorological Agency (MOEJ 2015). It shows expected temperature differences between the recent past (1984–2004) and future climate conditions (2080–2100) in the region. The colors indicate the average values for the RCP2.6, RCP4.5, and RCP6.0 scenarios, and nine RCP8.5 scenarios. In all scenarios, temperatures show a distinct increasing tendency. These increasing temperatures will have serious physical and socio-economic impacts.

Climate change poses a variety of threats. Figure 1.3 shows a map of the risks attributable to climate change and attendant socio-economic circumstances. The former includes increasing rainfall, storms, flooding, inundation, sea level rise (SLR), uncertainty in terms of agricultural production, and the occurrence of heat waves. To illustrate such risks, Fig. 1.4 shows the potentially inundated areas of

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T. Ito et al. (eds.), *Interlocal Adaptations to Climate Change in East and Southeast Asia*, SpringerBriefs in Climate Studies,
https://doi.org/10.1007/978-3-030-81207-2_1

Fig. 1.1 Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways (IPCC 2018)

Asia due to SLR in 2100 under RCP8.5/MIROC-ESM (Tamura et al. 2019). Lowland areas, such as the Mekong Delta, the Yangtze River Delta, and the Ganges Delta may be partially or heavily inundated by SLR. Indeed, China, Canada, Vietnam, the United States, Brazil, Australia, Indonesia, and India all face similar challenges in terms of having the world's largest potentially inundated areas. Included among the associated socio-economic issues are urbanization, population growth, increased migration, income disparity, volatile food prices, lack of insurance schemes, lack of financial resources to prepare for extreme events, and impact of information technology.

1.2 Climate Change Responses: Mitigation and Adaptation

There are two approaches to addressing the issue of environmental change: one is to remove the causes of the change; the other is to adopt measures that will allow societies to adjust to the adverse effects. In the context of climate change, these responses are referred to as mitigation and adaptation, respectively. Mitigation to reduce greenhouse gas (GHG) emissions and their role in climate change include energy conservation and the development of alternative energy sources, as well as forest protection and afforestation management. Adaptation, which serves to adjust human and natural systems to the assumed ongoing climate change, might include measures such as disaster prevention, as well as making changes in the cultivation of plant species and breeding new plant varieties.

Mitigation strategies are roughly divided into two categories: those that reduce the sources of GHG emissions and those that act as GHG sinks. Reducing GHG emissions would include improved energy efficiency in both supply and demand, as

Fig. 1.2 Changes in annual mean surface temperatures (°C) in Southeast Asia under each RCP scenario (MOEJ 2015)

well as the use of technologies for reducing GHG emissions. Supply-related reduction measures would include the development and widespread use of alternative energy derived from non-fossil fuels. Demand-related measures would involve energy conservation at various stages, including the production stage, the transportation stage, and the domestic utilization stage. Enhancing GHG sinks includes increasing GHG absorption by ecosystems through afforestation, re-forestation, forest management, and carbon capture and storage (CCS) or sequestration. Measures such as afforestation and appropriate forest management clearly contribute positively to the conservation of ecosystems; however, CCS is somewhat problematic because of its potential to adversely impact ecosystems.

Adaptation measures include the following (Hay and Mimura 2006):

- Avoiding or reducing the likelihood of adverse events or conditions. This means taking preventive measures against anticipated effects, e.g., improving catchment management, and avoiding excessive runoff and flooding.
- Reducing consequences. This involves measures to diminish damage that has already occurred, e.g., ensuring healthy reef and mangrove systems, which act as buffers during storm surges.

Fig. 1.3 Climate change and socioeconomic fragility in Asia (MFAJ 2017)

Fig. 1.4 Potentially inundated areas in Asia due to sea level rise in 2100 under the RCP8.5/MIROC-ESM. (Adopted from Tamura et al. 2019)

- Re-distributing or sharing risks. This includes measures to lessen the costs of damage by dispersing them among many people or over a long period, e.g., insurance schemes.
- Accepting risk. This means doing nothing, at least for a particular time, but includes the opportunity to learn from the experience.

It generally takes considerable time for mitigation measures to take effect, but they can provide wide-ranging benefits. In contrast, adaptation measures have a rather immediate effect, but tend to operate in limited areas. Although mitigation measures can be evaluated on the basis of GHG emissions, it is difficult to set similar baseline and result indicators for adaptation measures and to properly evaluate their effectiveness. Both approaches have specific advantages and can be viewed as complementary.

1.3 Vulnerability, Sensitivity, and Resilience

Figure 1.5 illustrates temporal changes in vulnerability corresponding to mitigation of, and adaptation to, climate change. Mitigation is intended to control the climate's external forces (hazards) while adaptation is intended to increase resilience or

Fig. 1.5 Temporal change in vulnerability corresponding to mitigation and adaptation to climate change (Komatsu et al. 2013)

Fig. 1.6 Interaction among exposure, vulnerability, and their adaptations (IPCC 2019)

adaptive capacity. The risk of climate-related impacts is a product of the interaction of climate-related hazards and the vulnerability and exposure of humans and natural systems (Fig. 1.6). Here, hazards refer to threats, and includes both hazardous events and trends. Exposure refers to the presence of people and assets in places that could be adversely affected.

Vulnerability to climate change is determined by (1) the magnitude of external forces, such as an increase in air temperature, SLR, and changing rainfall patterns; (2) the susceptibility of nature and society to these external forces; and (3) the

capacity of society to adapt to these external forces. Accordingly, societies that are easily damaged by climate change are considered to be highly vulnerable. Thus, the combination of larger climate hazards (external forces) and less adaptive capacity (less resilience) means higher vulnerability. Even under conditions where there is the same level of hazard, the risk will be dependent on the local situation. If the region has small exposure (e.g., slightly affected population and small assets) and good adaptive capacity to climate change, then the risk will not be so serious (and vice versa).

1.4 Approaches and Categories of Adaptation

1.4.1 Approaches

Two main approaches to adaptation have been developed to address adaptation: a top-down scientific approach and a bottom-up regional approach (Fig. 1.7). The scientific or top-down approach involves long-term adaptation measures by both national and local governments, and includes climate projections, their downscaling, impact/vulnerability assessments, and the planning of adaptation (e.g., Klein et al. 1999). In contrast, regional approach or community-based adaptation addresses challenges at the local level and seeks to promote the participation of stakeholders (especially those in the local community) in the process of formulating adaptive measures. This regional or bottom-up approach encourages people in the community to recognize their future risks and to participate in the planning and

Fig. 1.7 Dual approach for climate change adaptation. (Revised from Tamura et al. 2014)

implementation of adaptation measures (e.g., Adger et al. 2005). Dialogue between stakeholders may bridge these two approaches.

This book covers both research and activities among some East and Southeast Asia countries so that it can fill in the gap between two approaches including agriculture, disaster risk management, resource management, and human resource development.

1.4.2 Categories

Based on the timescale (short-term, mid-term, and long-term), adaptation measures can be further categorized as follows: (1) efforts to strengthen existing measures related to adaptation, (2) adaptive management for middle and long-term impacts, and (3) measures aimed at a fundamental improvements in sensitivity (Fig. 1.8). Enhancing adaptive capacity is the main objective at the initial level of adaptation, while improvement in sensitivity, including reconstruction and transformation, is the main goal at the latter level.

Fig. 1.8 Level and time scale of adaptation (Shirai et al. 2014)

1.5 Trends in International Policy and National Adaptation Plans (NAPs)

The Paris Agreement, adopted in December 2015 at the 21st Conference of the Parties (COP21) by the UN Framework Convention on Climate Change (UNFCCC), has a shared international long-term goal of “holding the increase in the global average temperature to well below 2°C above pre-industrial levels” and sets the direction toward net zero anthropogenic GHG emissions by the second half of the twenty-first century. With respect to adaptation, the agreement calls for “enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change”, and urges the parties to “engage in a process to formulate and implement national adaptation plans.”

The UNFCCC began its National Adaptation Programmes of Action (NAPA) in 2001 to support the efforts of the Least Developed Countries (LDCs) in addressing their urgent and immediate need to cope with the impacts of climate change. In 2010, the UNFCCC established the NAP process at COP16 in Cancun. Comparing the two approaches, NAPA is rather urgent and reactive and focuses on actions for LDCs to be taken primarily based on observed or past events. The NAP process is more proactive and, in addition to observed information, relies on future climate projections and their likely impacts (UNFCCC 2012). Of 153 developing countries, 91 have initiated the NAP process and 11 have submitted NAPs as of 2018 (UNFCCC 2018). Since the adverse impacts of climate change have been recognized by nearly all countries, NAPs are not limited to LDCs, but are promoted by both developing and developed countries, including the EU countries (UK, Germany, etc.), the USA, Japan, South Korea, and China. Japan formulated its “National Plan for Adaptation to the Impacts of Climate Change” in November 2015 (Cabinet decision 2015) and enacted the “Climate Change Adaptation Act” in June 2018. After formulating their NAP, national governments need to develop methodologies for monitoring and evaluating (M & E) the progress of their adaptation efforts.

1.6 Key Elements of a National-Level Adaptation Plan/Strategy

National-level adaptation plays a key role in adaptation planning and implementation. It serves to coordinate adaptation responses at subnational and local levels, where diverse processes and outcomes are called for (IPCC 2014). National-level coordination includes the provision of information about potential risks in order to strengthen the actions of state and local governments. These activities provide policy frameworks that guide decisions at the subnational level, coordinating the creation of legal frameworks, directing sectoral action and targeting resources for national development (agriculture, fisheries, health, ecosystem protection, among

others), protecting vulnerable groups, and providing financial support for the various levels of government.

As adaptation activities have progressed, multiple challenges have emerged, including how to manage the decision-making process, how to develop effective strategies and plans, and how to implement them. In this regard, individual roles within a multilevel governance system have become an issue made more complex by the need for horizontal coordination among different agencies and departments, and vertical coordination among various stakeholders, from national to regional to local actors (IPCC 2014). National governments need to coordinate and enhance appropriate multilevel adaptations. Accordingly, they should (1) share common understanding among the line ministries in order to ensure that concerted actions are taken with minimum effort and cost, and that duplication is avoided, (2) prioritize actions according to evidence, recognizing the limitations of time and budget, and (3) allocate a portion of the national budget to adaptation policy, that is sufficient to assess the potential effectiveness of adaptation measures.

UNFCCC (2012) summarizes the steps associated with each of the elements of national adaptation plan formulation for LDCs (Table 1.1). One of several key milestones under Element A is the establishment of institutional arrangements that undertake coordination and leadership in the process, including internal coordination with line ministries and role allotment. Element B includes key activities related

Table 1.1 Steps under each of the elements of the formulation of national adaptation plans (UNFCCC 2012)

Element A. lay the groundwork and address gaps

1. Initiating and launching of the NAP process
2. Stocktaking: Identifying available information on climate change impacts, vulnerability and adaptation and assessing gaps and needs of the enabling environment for the NAP process
3. Addressing capacity gaps and weaknesses in undertaking the NAP process
4. Comprehensively and iteratively assessing development needs and climate vulnerabilities

Element B. preparatory elements

1. Analyzing current climate and future climate change scenarios
2. Assessing climate vulnerabilities and identifying adaptation options at the sector, subnational, national and other appropriate levels
3. Reviewing and appraising adaptation options
4. Compiling and communicating national adaptation plans
5. Integrating climate change adaptation into national and subnational development and sectoral planning

Element C. implementation strategies

1. Prioritizing climate change adaptation in national planning
2. Developing a (long-term) national adaptation implementation strategy
3. Enhancing capacity for planning and implementation of adaptation
4. Promoting coordination and synergy at the regional level and with other multilateral environmental agreements

Element D. reporting monitoring and review

1. Monitoring the NAP process
 2. Reviewing the NAP process to assess progress, effectiveness and gaps
 3. Iteratively updating the national adaptation plans
 4. Outreach on the NAP process and reporting on progress and effectiveness
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to technical assessments that enable a country to make informed decisions based on scientific methodologies and findings. Impact assessment, prioritized impacts, adaptation measures, internal coordination with line ministries, and role allotment are commonly required. The activities under Element C of the process comprise the implementation strategies for NAPs. Element D, reporting, monitoring and reviewing the process of formulating and implementing NAPs, entails collecting information on the process, assessing it through a national monitoring and evaluation (M&E) system and providing outputs for reporting on progress to the COP. The guidelines suggest that the National Adaptation Plan process should be designed to be flexible and non-prescriptive; hence, countries may apply the suggested steps based on their particular circumstances, choosing those steps that add value to their planning process and sequencing activities. Figure 1.9 shows the progress made in the development of the NAP process from 2015 to 2018.

Adaptation planning and implementation are dynamic iterative learning processes that recognize the complementary roles of adaptation strategies, plans, and actions at different levels (national, subnational, and local) (IPCC 2014). Iterative risk management is a useful framework for decision-making in complex situations characterized by large potential consequences, persistent uncertainties, long timeframes, potential for learning, and multiple climatic and non-climatic influences changing over time (Fig. 1.10). People and knowledge shape the process and its outcomes.

Fig. 1.9 Progress made by developing countries in the process used to formulate and implement national adaptation plans by process element from 2015–2018 (FCCC/SBI/2018/INF.13) (UNFCCC 2018)

Fig. 1.10 Climate-change adaptation as an iterative risk management process with multiple feedbacks (IPCC 2014)

1.7 Adaptation in Local Governments: Japan's Case

NAPs can serve as the main driver to promote regional adaptation or guide the actions taken by local governments. The impacts of climate change, vulnerabilities, and priorities vary substantially depending on regional characteristics. Each local government should consider adaptation measures proactively and address them carefully.

The Japanese government and research communities have conducted extensive studies on the projected impacts of climate change and have investigated suitable adaptation measures (MOEJ 2008, 2010; MEXT et al. 2009; CSTP 2010). The Ministry of Environment (MOEJ 2008) has introduced the principle of “wise adaptation” based on the following concepts:

1. As a policy development operating under uncertainty, adaptation should be based on an effective, efficient and flexible approach. In spite of significant progress in research and policies, uncertainties still exist in the projections of future climate change, the associated impacts and social trends. Because rapid advances are occurring in global observations and climate projections, adaptation plans that can be revised every few years should be adopted, as opposed to implementing unchangeable measures.

2. Wise adaptation considers climate change adaptation in the wider context of sustainability and the well-being of society. Adaptation to climate change should contribute to other social goals, such as mitigation of climate change, the creation of an environmentally friendly, safe and secure society in accordance with sustainable development goals (SDGs).

The Japanese Diet enacted Japan's "Climate Change Adaptation Act" in June 2018, according to which the national government shall formulate an NAP to promote adaptation in all sectors. Methodologies for monitoring and evaluating (M & E) the progress of adaptation efforts need to be developed.

Climate change impacts and vulnerabilities depend on local conditions. The implementation of adaptive measures is mainly conducted by local communities consistent with the overall planning of national adaptations. As shown in Fig. 1.11, the climate change adaptation act of Japan recommends that prefectures and municipalities assign "local climate change adaptation center (LCCAC)" as local climate change data collection and provision centers. As of August 2021, 34 among 47 prefectures and 9 cities have established local centers. For example, Ibaraki Prefecture established Ibaraki Local Climate Change Adaptation Center (iLCCAC) at Ibaraki University in April 2019 (<https://www.ilccac.ibaraki.ac.jp/>). A-PLAT (<http://www.adaptation-platform.nies.go.jp>), which is organized by national climate change adaptation center, is providing national data and compiling local data. LCCAC provides more locally specific information and support for adaptation planning in local municipalities. These horizontal and vertical collaboration efforts are expected to

Fig. 1.11 Climate change adaptation act in Japan (MOEJ 2018)

fill the gap between scientific and regional approaches for adaptation, as shown in Fig. 1.7, and are significant for promoting resilient adaptations.

1.8 Lessons Learned

Developing countries with high vulnerability that face serious adverse impacts from climate change will need to increase their adaptive capacities. Long-term targets would include the ability to apply their own traditional experiences and knowledge of natural disasters, and to develop the capacity to implement their own monitoring and prediction techniques. To enhance these adaptive capacities, it is critical to establish a social system that can promote information collection and to share and raise awareness of the importance of these activities. Similar methodologies have been implemented to promote regional development. Indeed, adaptation is sometimes regarded as a means to accomplish development objectives, while development can be seen as the means to achieve adaptation objectives (McGray et al. 2007). In other words, because of the overlap between adaptation and regional development, increasing adaptive capacity depends, to a significant extent, on regional development paths. In this sense, it is difficult to separate actions to reduce vulnerability to climate change from those promoting sustainable development when there are limited resources that can be allocated to both action streams. Not surprisingly, some of the SDGs adopted at the Sustainable Development Summit in 2015 recognize this close connection. In particular, the targets for SDG 13 “Climate action (Take urgent action to combat climate change and its impacts)” include strengthening resilience and adaptive capacity to deal with climate hazards (United Nations 2018). Thus, decision makers have come to realize that ‘mainstreaming’ or incorporating adaptation policies into existing socioeconomic policies without distinguishing between climate change policies and, for example, land use and agriculture planning, is a logical evolution of the preferred solution.

Adaptation and mitigation serve as twin pillars in the battle against climate change. Together, they represent the main strategies for improving social resilience to climate change, ensuring human security and promoting sustainable development. As part of the battle plan, it is essential to review and reconstruct our national policies on land use, environmental use and city/rural planning. The ideal of a low-carbon and resilient society needs to be aggressively promoted so that a sustainable society can ultimately be created. The high-level target is to adopt a flexible response to climate change in order to sustain a dynamic and vital society. Importantly, wise adaptation to climate change must be implemented according to regional realities, changing regional and social modalities while simultaneously producing solutions to other pressing problems.

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