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Chapter 6

Approaches to Climate Change Adaptation: A Case Study of Agricultural Initiatives in Japan

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1. Introduction

Climate change (CC) impacts are threatening around the globe and they are not limited to developing countries. CC adaptation in developing countries is mostly focused on community-based adaptation to help the poorest and the most vulnerable societies by empowering communities to become resilient to CC impacts (Huq and Reid, 2007; Ayers and Huq, 2009). In contrast, developed countries are presumed to have a low vulnerability to CC (Ford and Berrang-Ford, 2011). As a result, not many studies are conducted in the developed countries to see the effectiveness of policies and

actions taken for CC adaptation. However, as the adaptation is location specific and solutions and approaches are diverse (Agrawal, 2010), it is worthwhile understanding cases in developed countries.

Impacts on rice production are anticipated in Japan and several approaches are adopted to maintain the quality and quantity of rice production. Study of these approaches could yield useful lessons for other rice-producing countries in the Asia-Pacific region. Keeping this in mind, this chapter examines the adaptation measures taken in the agricultural sector in Japan, focusing on rice production, and it identifies critical messages and gaps with a view to finding effective ways to meeting Japan's adaptation needs.

1.1 Observed climate change impacts in Japan

Due to increasing temperatures and less or too much rain, symptoms, such as chalky grain, have been observed in Japan (Committee on Impacts of Global Warming and Adaptation, 2008). Chalky grain is the murky colour of rice grain which is considered to be poor quality. First-class quality rice is the determinant of the highest rice price, and its criteria are mostly based on the appearance of harvested rice, such as size and colour, as well as the amount of grain moisture. Negative impacts on the quality of crops have a direct effect on the market price, sales and the income of the farmers. In addition to the direct impact of changing temperatures on crops, shifts in crop pests have also been observed. For example, grain damage caused by

the infestation of rice leaf bug, rice bug and mirid bug has become more frequent (National Agricultural Research Centre for Tohoku Region, 2006). An increase in the infestation period of rice stem borer (*Chilo suppressalis*) was observed with the extended duration of warm temperatures during autumn (Seino, 2008).

Negative climatic impacts on rice have increased since 2000, especially in the northwest of Japan, including the Niigata prefecture, and in the southern part of Japan, including the Miyazaki prefecture, where the average temperatures during the grain-filling period are increasing (Seino, 2008). Niigata is located on the island of Honshu on a plain between the coast of the sea of Japan and Echigo Mountains. With a humid subtropical climate, Niigata receives about 1,821 mm precipitation per year with rainfall during July to November and snowfall during December to March. The average daily mean temperature (about 13.9 °C), the average high temperature (about 30.6 °C in August) and the average low temperature (0.1 °C in February) in Niigata varies significantly for its four distinctive seasons (Japan Meteorological Agency, 2012a). Miyazaki is located on the island of Kyushu surrounded by the Pacific Ocean. With the warm Japan Current, it enjoys a mild subtropical climate. Miyazaki receives about 2,508.5 mm precipitation per year with heavy rain during June to September. The average daily mean temperature (about 17.4 °C), the average high temperature (about 31.4 °C in July) and the average low temperature (2.6 °C

in January) in Miyazaki varies in four distinctive seasons (Japan Meteorological Agency, 2012b). Such seasonal variations in temperature have clear implications for rice production and the quality of rice.

Niigata experienced degraded rice quality in 1999 due to the abnormal summer temperatures and in 2004 due to the large number of typhoons. In 2010 the first-class quality rice in Niigata was about 19.7 per cent which is the lowest ever, affecting farmers' income (Ministry of Agriculture, Forestry and Fisheries (MAFF), Japan, 2010a). The average minimum temperature in Niigata was 25.9 °C during August 2010, which was just 0.1 °C below the threshold temperature for chalky grains (Ouchi, 2010). In 2007, Miyazaki was affected by the *foehn* phenomenon after the typhoon, resulting in an extremely low rate of first-grade rice. The *foehn* phenomenon is known to be an extremely dry and hot local air which occurs when the humid wind flows over the mountain or when the hot air in the upper levels falls along the leeward side of the mountain. Severe impacts on rice quality in Niigata and Miyazaki encouraged these prefectures to respond rapidly to climatic variability.

1.2 Future climate change projections in Japan

In the medium term until the 2050s, a gradual increase in temperature and carbon dioxide (CO_2) are predicted to benefit rice production in Japan (Yokozawa and Iizumi, 2009). Rice yields may increase for a while because of the reduced impact of cold summers and the CO_2 fertilisation effect

which is caused by increasing photosynthesis with increasing CO_2 concentrations (Seino, 2008).

In Hokkaido, rice quality and yield are likely to increase if the geographical suitability for rice production and farmers' capacity permits (MAFF, Japan, 2008). However, such an increase in yield may not occur in eastern and southern Japan since the temperature increase in those areas is already rapid, particularly in summer and autumn. An increase in total production will peak once the temperature exceeds the optimum range for growing rice, especially during the flowering and grain-filling periods (Yokozawa and Iizumi, 2009).

In the long term, towards the end of this century, both the quality and the quantity of rice in the whole of Japan are likely to decline due to the compound stresses caused by CC (Committee on Impacts of Global Warming and Adaptation, 2008).

2. Research objectives

This chapter aims to examine how a developed country such as Japan is currently responding to CC by studying various initiatives in the agriculture sector on a case study basis. The objective is to know if what is being done for CC adaptation in Japan is sufficient and what more can be done.

3. Research methods

A literature review, a consultation workshop with experts and an open-ended interview with personnel at prefectural-level government, agricultural

research institutes and extension agencies were conducted to examine how Japan is currently responding to CC in the agriculture sector. The reviewed literature includes reports and documents published by the national and local governments and research institutes, peer-reviewed journals, academic remarks and other technical books.

A policy consultation workshop entitled Adaptation in Agriculture and Water Sectors in Japan and Its Relevance for Developing Countries in the Asia Pacific was held on 13 July 2010 in Pacifico Yokohama, Japan. It was a part of the annual International Forum for Sustainable Asia and the Pacific organised by the Institute for Global Environmental Strategies.

Interviews were conducted in two case-study locations: the Niigata and Miyazaki prefectures in 2010. These locations were selected based on the publications and announcements of the MAFF, Japan, and the Ministry of Foreign Affairs of Japan. The presence of CC adaptation-relevant initiatives in the agriculture sector was the main criterion. Interviews were conducted with the officers of the Agricultural Production Section and Research Management Office of Niigata Prefectural Government, the Niigata Agricultural Research Institute, the Global Warming Research Centre for Agriculture and Fishery of Miyazaki, the Prefecture Agricultural Experiment Station and the Miyazaki Prefecture Central Agricultural Development and Extension Centre.

4. Findings

4.1 Adaptation strategies at the national level

4.1.1 *Overall adaptation strategies*

Japan's leading adaptation scientists group, the Commission on Direction of Climate Change Adaptation, applies the definition of adaptation from the Intergovernmental Panel on Climate Change (IPCC), which is 'Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' (IPCC, 2001, p. 750).

Our review of existing policy documents in Japan suggested that if one only looks for the term 'adaptation to climate change', such policies in Japan would be extremely limited. Table 6.1 lists basic projects, strategies and plans that are either directly addressing CC adaptation or have adaptation benefits. Ministries such as the Ministry of the Environment, the MAFF, the Ministry of Education, Culture, Sports, Science and Technology (MEXT), the Ministry of Land, Infrastructure and Transport (MLIT), and the Ministry of Health, Labour and Welfare (MHLW) are actively involved in implementing current adaptation policies.

It is clear from Table 6.1 that the Japanese government has put special emphasis on research and technology development especially for predicting future climate and assessing the potential impacts.

These approaches are essential for setting the basis for strategic plans and effective implementation. However, as the Organisation for

Economic Co-operation and Development's (OECD's) environmental performance review of Japan pointed out, a comprehensive national legally binding adaptation strategy is yet to be established in Japan (OECD, 2010).

4.1.2 *Adaptation in the agriculture sector*

Several past developmental initiatives in the agriculture sector with adaptation benefits already exist in Japan, including the development of an irrigation network with huge support from public works (Council of Food, Agriculture and Rural Area Policies, 2006). New crop varieties and farming practices have been developed over the years to cope with the changing natural environment and changing farming and consumer markets. For example, the Hokkaido region was believed to be too cold for growing rice in the 19th century. Rice production was the lowest priority for agricultural development during that time. However, in response to the demand for rice, crop varieties and cultivation techniques were improved significantly after the mid-20th century with the effort of local practitioners. Now the rice yield and rice quality in Hokkaido are ranked as some of the highest in the nation (Hokkaido Agricultural Policy Department, 2009).

In terms of specific responses to CC, the MAFF established a Global Warming Taskforce with a clear emphasis on greenhouse gas (GHG) mitigation in October 2009 (MAFF, Japan, 2010b). The taskforce is headed by the minister of MAFF and managed by the Environment and Biomass Policy Division of the minister's secretariat, the MAFF. The main

objectives for the taskforce are (i) to reduce GHG emissions from agricultural activities, (ii) to absorb GHG emissions from effective forest and land management and (iii) to reduce GHGs emissions by facilitating biomass energy and renewable energies (MAFF, Japan, 2010b).

Adaptation strategies stated in Chapter 3 of 'MAFF Comprehensive Strategy for the Climate Change (decided in June 2007 and revised in July 2008)' indicates the promotion of adaptation through training and sharing present technologies, and developing, demonstrating, introducing and reviewing technologies (MAFF, Japan, 2008). The MAFF has conducted CC impact assessment in collaboration with counterparts in each prefecture to facilitate the technical assistance for agricultural production. Impacts on major crops (symptoms such as chalky rice grain) and possible adaptation measures proposed by the national and prefectural agricultural research institutes were compiled (MAFF, Japan, 2007). The development of heat- and disease-tolerant agricultural crops has been initiated at the national- and prefectural-level research centres. In the case of rice production, *Nikomaru*, the high-temperature-resistant rice variety developed by the National Agriculture and Food Research Organisation, is already being promoted around the Kyusyu area (MAFF, Japan, 2008). However, no direct national regulations were established for CC adaptation by the MAFF and most approaches focused on research and related capacity-building. As a

consequence, adaptation policy measures are not so apparent in the form of incentives, regulations or approaches.

4.2 Adaptation strategies at the prefectural and local level

Climate-related issues are handled by multiple divisions in the Niigata and Miyazaki prefectures, mostly by the social and environmental divisions that deal with livelihoods, health and water management and not by the agricultural division. In other prefectures, agricultural divisions/offices are responding to such needs as a priority, depending on the awareness, understanding, resources available, willingness of the prefecture and the severity of the climatic impacts that these prefectures have perceived.

4.2.1 *Niigata*

The Global Environment Countermeasure Office in Environmental Planning Division of Residents' Life Environment Department is in charge of CC issues. It has developed the Niigata Global Warming Regional Countermeasure Promotion Plan 2009 (*Niigataken chikyu ondanka taisaku chiiki suishin keikaku*, 2009) (Niigata Prefecture, 2009a). This focuses on GHG mitigation, and only one paragraph out of 76 pages mentions adaptation.

The Agriculture, Forestry and Fishery Department issued the 'Agriculture and fishery vision 2006 (*Nourin Suisan Vision*, 2006)' (Niigata Prefecture, 2006) based on the Niigata prefecture's overall basic

development plan towards 2020, namely ‘Dream developing policy plan 2006 (Yume Okoshi Seisaku Plan, 2006; revised in 2009)’ (Niigata Prefecture, 2009b). Only a few components considering CC have been included in the vision – that is, environmental protection through soil, air and water purification, and sustainable forest management.

To respond to the degrading rice quality due to increasing temperatures, the development of a new rice variety, *Cho-Koshihikari*, was started in April 2010 as a project of the Agriculture, Forestry, and Fisheries Department in the Niigata prefecture. (In Japanese, *Cho* means super and *Koshihikari* is one of the rice varieties which is popularly planted in Japan today. The superior flavour of *Koshihikari* is widely accepted by consumers and thus, by adding *Cho,* it is intended to develop super *Koshihikari*.) The prefecture aims to create a heat-tolerant, late-maturing rice variety which is as tasty as that of the existing Niigata-brand mid-maturing rice variety *Koshihikari* or the early-maturing variety, *Koshiibuki*. The project is fully funded by the prefectural government (approximately 60 per cent of the total project costs) and the Japan Agricultural Cooperatives (JA) group, and part of the revenues comes from rice seed sales. A premium was added to rice seeds that farmers buy from the seed companies. Farmers are informed of this in the seed order form. Since there is too much dependence on the existing variety (*Koshihikari*), its development will diversify the rice

varieties planted in the region and reduce the damage risk from the fluctuation in temperature during the critical rice-cultivation period.

The development of the early-maturing rice variety, *Koshiibuki*, was also initiated to deal with changing climatic conditions after the prefecture experienced cool weather in 1993, drought and heat in 1994, and hot night temperatures in 1999. About 55 per cent of total rice production failed to be graded as first-class quality in 1999 (as noted by the government officials of the Niigata prefecture during the interview). Even before the wide acknowledgement of CC, research had been conducted to cope with fluctuating temperatures. With its continuous efforts, in 2001, the Niigata prefecture started commercial production of *Koshiibuki*, the rice variety that is tolerant to hot temperatures during the grain-filling period with comparable quality and taste of *Koshihikari*. Usually the prefecture's agricultural research centre develops and tests suitable varieties of crops (including rice), registers them as recommended varieties, and introduces them into commercial-scale production. This process often takes 10–15 years.

The prefectural government also provides guidance to farmers through extension services. It recommends that farmers fix the planting date on 10 May each year (about 7–10 days later than the conventional date) in order to delay the rice spike emergence period. It also recommends that farmers plant *Koshihikari* in 70 per cent of their rice paddy and other

varieties in 30 per cent to reduce yield and quality decline from epidemics and widespread crop loss due to monoculture (personal communication with Agricultural Production Section and Research Management Office of Niigata Prefectural Government). The latter recommendation has not been welcomed by farmers because of the high market value of *Koshihikari*, even though they could reduce the risks of dependency on a single variety. Hence the prefecture has to widen its genetic base of high-quality rice varieties so that farmers can cultivate different genotypes while benefiting from the same or similar high-quality rice that the prefecture is known for.

4.2.2 *Miyazaki*

The Environmental Administration Division of the Environment and the Forest Department are in charge of the prefectural CC policies. 'Miyazaki global warming countermeasure implementation plan (Miyazaki chikyu ondanka taisaku jikko keikaku)' was issued in 2000 (Miyazaki prefecture, 2012). Similar to the Niigata prefecture, most activities promoted by the Environmental Administration Division focuses on mitigation.

Independently of the above plan, the Agricultural and Fishery Administration Department has recently issued three major plans to promote research into global warming, to showcase global warming adaptive agricultural management and to develop mitigation technologies, including bioenergy such as poultry manure power plants (Global Warming Research Centre for Agriculture and Fishery, 2008). In 2008 the prefecture

individually established the Global Warming Research Centre for Agriculture and Fishery under the supervision of the Agricultural and Fishery Administration Department. This centre is one of very few research institutes specifically established for the purpose of studying global warming for agriculture at the prefectural level in Japan. By implementing pilot model projects for CC, the research centre is supporting the implementation of the Production Area Structural Reform Plan to Cope with Global Warming in the Miyazaki Prefecture (*Miyazakiken chikyu ondanka taio sanchi kozo kaikaku keikaku*)' for the Agricultural and Fishery Administration Department. Since the Miyazaki prefecture is one of the major citrus- and mango-producing areas, the government officials we interviewed believed that global warming could open up new opportunities for producing alternative crops, such as tropical fruits, and diversifying the agricultural products of the Miyazaki prefecture. A few months after the interview, the Miyazaki prefecture announced that it would test-grow lychee and jujube to revitalise the region's high-quality local products. Warmer temperature may also reduce the fuel consumption involved in greenhouse mango production since approximately 6 l of fuel is currently consumed to produce one mango.

As mentioned before, Miyazaki is located in southern Japan so its climate is warmer than that of many other prefectures and it is experiencing degrading rice quality. Therefore the development of a heat-resistant rice

variety has been initiated. The prefecture is growing two major rice varieties: *Koshihikari* (early-maturing variety planted in February, 3,000 ha in the prefecture) and *Hinohikari* (mid-maturing variety, 1,000 ha). The quality of both rice varieties was affected by the changing climate in the form of an increase in chalky grain, pests, viruses, and invasive species (personal communication with Central Miyazaki Agricultural Extension Centre). *Koshihikari* is susceptible to rice blast and wind, and its flowering coincides with the high typhoon rainfall. The new early-maturing variety currently being developed (*Miyazaki* No.45) will have a shorter stem and hence resistant to lodging (lodging refers to collapse of rice plants due to unfavourable weather and nutrient management). The development of this variety is supported by the prefecture and is in the field experimental stage, to be ready for adoption in a few years. Funded by the national government, *Hinohikari* was developed by the Agricultural Research Institute in the Miyazaki prefecture for producing good-flavoured rice even in a warm climate, such as in the Kyushu region (MAFF, Japan, 2009).

4.2.3 *The role of cooperatives and local extension agencies*

In Japan, extension agencies and JA assist farmers at the local level. Extension agents work under the prefectural administration, and this is linked with the agricultural department of the prefecture and the prefectural agricultural research centre. The JA is a Japanese farmers association initiated under the Japan Agricultural Cooperatives Law 1947 by the General Headquarters of the Allied Forces of the United States. The idea of

JA was to formulate an autonomous agricultural organisation for farmers in order to ensure equal rights to peasants. However, under the severe food shortages after World War II, it was difficult to make JA completely independent from the government. In the post-war era, the JA has been playing a middle-man role between the government and farmers. Although most of the farmers are the members of JA, the organisation itself is partly managed by the farmers (Yamashita, 2009).

Technicians at the extension centre give advice and training to farmers according to guidance from the research centres. Due to the limited number of staff, the extension agency may not always be able to cover all of the municipalities so they often collaborate with local JA branches to reach farmers. In most instances the extension centre advises JA agents to instruct lead farmers in the district, and lead farmers disseminate the instructions to all other farmers. In Miyazaki, extension agents and JA provide all farmers with information about farming techniques for efficient water and fertilizer management in the critical stages of cultivating rice. In addition, they organise training and workshops after harvesting (off season). In the year of extreme weather, more training and meetings were held for review and improvement. Interviews with extension agents in the Central Miyazaki Agricultural Extension Centre revealed that the extension agents do not have a specific mandate to initiate work on CC. Most of their efforts are dedicated to reaching out to farmers in the area to deal with regular crop-

production-related issues, such as pest control and irrigation, and no special training CC adaptation has been imparted to the extension agents. Similarly, JA does not have a specific division in charge of CC matters. Our interviews also did not reveal the existence of specific training programmes for farmers to deal with the vagaries of the climate.

5. Analysis and discussions

Figure 6.1 shows the analysis of adaptation actions at each level of government in Japan. The national government has been playing an important role in furthering the understanding of climate science and its application. The national government provided direction through reports such as 'Direction of Climate Change Adaptation (Commission related to the Direction of Climate Change Adaptation, 2010)' by the MOE, the 'Wise Adaptation' report by the MOE, and the 'Climate Change Adaptation Report by Item' to facilitate decision-making at the prefectural level (Committee on Impacts of Global Warming and Adaptation, 2008; MAFF, Japan, 2007). The national government also supports research in the field of CC forecast, impact and vulnerability assessment, and to a limited extent the identification of adaptation technologies and practices.

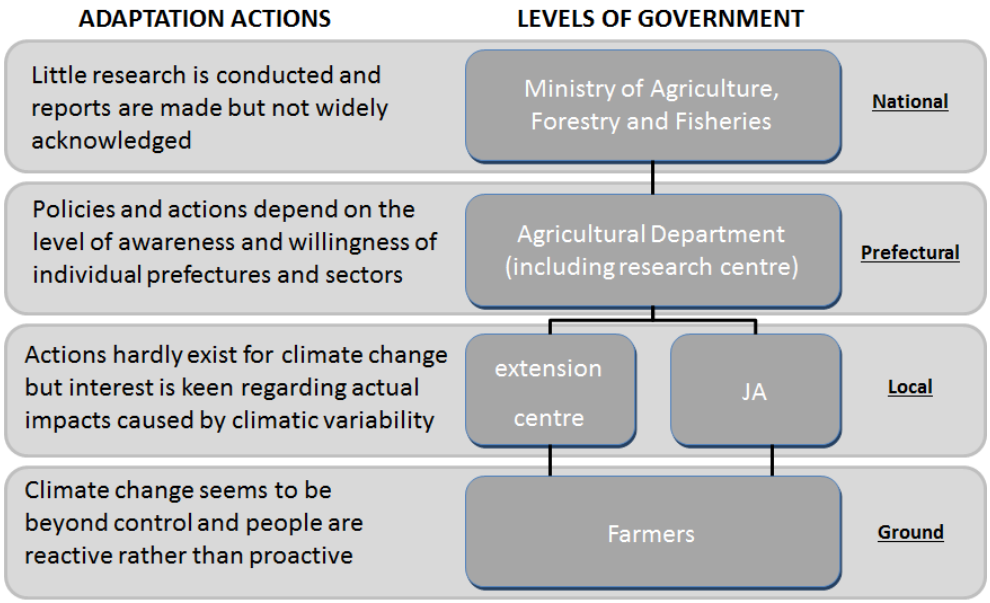

Figure 6.1: Status of CC adaptation actions at different levels of government with a focus on agriculture.

Source: Authors' assessment of field surveys and consultations

However, most of the current national initiatives on adaptation are limited since those initiatives are still at the stage of research. They are not widely acknowledged and are not at the stage of resource mobilisation for wider implementation. In addition, most of the existing sector-based adaptation projects are independently conducted by the different ministries in different periods (Table 6.1). They are not fully coordinated with other relevant sectors. Since the process of dialogue among various affected groups is required to deal with complex CC issues (Brown *et al.*, 2011), the current approach could easily cause fragmentation and unnecessary duplication.

At the local level the line departments such as agricultural extension and other collaborating institutions such as JA have not conducted any training programmes that are aimed at awareness generation or imparting specific skills for farmers to deal with long-term CC impacts. Although the MAFF has conducted CC impact assessments in collaboration with counterparts in each prefecture to facilitate technical assistance for agricultural production, it has not yet reached the local level. CC action hardly exists despite direct interest in local climatic impacts.

On the ground, communication channels between prefectural agricultural research centres and farmers appear to be highly dependent on JA due to the limited personnel within the prefectural extension departments. CC seems to be beyond the control of farmers. Everyday work is their priority, which makes them unreactive to the impacts of CC. In fact, CC impact varies every year with forecasts affected by uncertainties, which makes it difficult for farmers to respond from a long-term perspective.

The context of adaptation is seen differently in Japan, where strategies to enhance adaptive capacity in the farm sector is dominated more by ‘quality’ concerns than ‘yield’ concerns, which is the priority in most developing countries. At the national level, initiatives have been established to deal with CC adaptation more in terms of promoting research on CC impact projections that could set the path for planned adaptation in the future. More concrete actions on the ground have been initiated by

prefectures, including the development of heat-tolerant high-quality rice varieties, downscaling climate impact projections for agriculture, and chalky grain warning systems for maintaining high-quality rice. At the local level, people are found to be more concerned about dealing with existing climate variability than long-term CC.

The adaptation picture in Japan is emerging but fragmented, and more needs to be done. While well-informed approaches are something that may set Japan apart from other countries, the lack of a mechanism that coordinates and scales up local initiatives could result in the 'reinvention of the wheel' by other actors. Hence we propose a framework for horizontal and vertical coordination among ministries, sectors and players to 'scale up' the initiatives already taken up at the prefecture and local levels, and to make them interact with the government's plan and support (Howden *et al.*, 2007; Reid, Huq and Murray, 2010; Regmi, 2012). Such a coordination mechanism is possible at the national level. Since Japan already has relatively high adoption rates of advanced agrotechnology, the next step is to make available downscaled CC projections to all prefectures for initiating appropriate actions at the local level. In addition, Japan needs to address the changing socioeconomic conditions, including demographics and its implication for CC adaptation. One important lesson that could be learned from Japan, and that has direct relevance to the developing countries in the Asia-Pacific region, is that the local governments and institutions are

strengthened to initiate adaptation actions even without significant support from the national level.

6. Limitations

This chapter is based on consultation meetings and interviews with various government institutions at the prefecture level. Though such an approach is not problematic, it could be difficult, as it is difficult for government officers to acknowledge the existing gap. In addition, the study has shown that technological interventions still play a major role in CC adaptation when compared with socioeconomic and community-driven approaches, which appear to be at the centre of CC adaptation initiatives in most developing countries. However, with the framework this research has followed, we cannot conclusively say that there are no community-based initiatives in Japan, but they are definitely not as visible as technological interventions.

7. Conclusion

Overall, although developed countries put less emphasis on the need for adaptation, this study revealed that the institutional system for adaptation in Japan needs to be strengthened. There are some actions emerging specifically at the local level of government and sectors but they still lack systematic approaches to efficiently deal with CC in terms of central-level coordination and strategising. Developed countries also need comprehensive policies similar to those of the developing countries. The following

recommendations emerge from this study. First, there is a need for capacity-building of local functionaries for science-based adaptation. Topics such as downscaling of CC projections and impacts would be useful for local-level decision-making. Second, communication and coordination between different administrative levels needs to be improved, ideally with a greater role at the national level such that lessons learned across the prefectures can be shared effectively. Third, there is greater need for coordinated and integrated policies and programmes for avoiding duplication in different sectors and governments. Finally, there is a need for the diversification of adaptation strategies from technology orientation to social orientation.

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Table 6.1: Major adaptation initiatives in various sectors in Japan

Sectors	Initiatives
Cross-cutting	Climate Change Symposium 2007 (Cabinet Office)
	Reinforcement of weather and climate data observation

	using Greenhouse gases Observing SATellite (Japan Meteorology Agency; JMA) □ Comprehensive research for global warming 2005–2009 and report on Wise adaptation 2008 (MOE) □ Establishment of data integration and analysis system (MEXT) □ Kakushin Project for future forecast of CC, 2007–2011 (MEXT) □ Direction of CC adaptation (MOE 2010)
Agriculture and water	□ Annual CC impact report by product item (climate change adaptation report by item 2007) (MAFF, Japan, 2007) □ Technology development and impact assessment of global warming for agriculture and fishery sectors, 2002–2005 (MAFF) □ Water-shortage information portal from 2002 (MLIT, MHLW, MAFF and JMA) □ Interim report on integrated water-resource management addressing CC and other risks 2008 (MLIT)

	□ Comprehensive strategy for the CC 2008 (MAFF) □ Vision of aqueduct 2004 (MHLW)
Ecosystems	□ Project of monitoring site 1,000 from 2003 (MOE) □ Comprehension of high-risk mountainous disaster area and research on proactive measurements for mountainous areas □ Understanding high-risk mountainous disaster area (Forestry Agency) □ Third strategy on biodiversity 2007 □ Comprehensive strategy for CC, 2008 (MAFF)
Disaster management	□ Research on advanced technology in risk assessment and observation of severe weather, 2009–2013 (MLIT and JMA) □ Abnormal climate report, 2005 (JMA) □ Review of water disaster risk-assessment method 2008 and how-to information about designing a Hazard Map, 2005 (MLIT) □ Disaster Risk Information Platform, 2008 (MEXT)

	□ Research on landslide and wind/water disaster occurrence prediction by multiparameter radar, 2007 (MEXT) □ Plan for CC adaptation in water disaster-management sectors, 2008, recommendation in relation to the landslides in midterm vision, 2007, and Urban and Rural Transport Strategies, 2005 (MLIT) □ Strategy for the 21st-century environmental nation, 2007 (MOE)
Health	□ Research on global health issues including 'annual research on health impact by climate change from 2000' and 'water management to cope with climate change 2009'(MHLW)

*Sources***:** Developed from Council of Science and Technology Policy (2010) and Pacific Consultants Co LTD (2010)

References

A. Agrawal (2010) 'Local Institutions and Adaptation to Climate Change', in R. Mearns and A. Norton (eds.) *Social Dimensions of Climate Change*, (Washington DC: World Bank), p.173.

J. Ayers and S. Huq (2009) Community-Based Adaptation to Climate Change: An Update, Briefing of International Institute for Environment and

Development, http://pubs.iied.org/17064IIED.html, date accessed December 30, 2012.

A. Brown, M. Gawith, K. Lonsdale and P. Pringle (2011) *Managing Adaptation: Linking Theory and Practice* (Oxford: United Kingdom Climate Impacts Programme).

Commission related to the Direction of Climate Change Adaptation (2010) *Direction of Climate Change Adaptation (Kikohendo tekio no hokosei)* (Tokyo: Ministry of the Environment, Japan).

Committee on Impacts of Global Warming and Adaptation (2008) *Wise Adaptation* (Tokyo: Ministry of the Environment, Japan).

Council of Food, Agriculture and Rural Area Policies (2006) The Adequate Role of National and Local Government on Land Improvement Planning *(Tochikairyo jigyo ni okeru kuni to chiho tono tekisetsu na yakuwari buntan)* http://www.maff.go.jp/j/nousin/sekkei/nn/n _sikumi/pdf/buntan.pdf, date accessed November 18, 2010.

Council of Science and Technology Policy (2010) Status of climate change adaptation activities *(Kikohendo tekiosaku ni kansuru torikumijokyo ni tsuite)*, http://www8.cao.go.jp/cstp/sonota/kikoutf/1kai/siryo2.pdf, date accessed August 2010.

J.D. Ford and L. Berrang-Ford (2011) 'Introduction', in J.D. Ford and L.B. Ford (eds.) *Climate Change Adaptation in Developed Nations: From Theory*

to Practice (Dordrecht, Heidelberg, London, New York: Springer), pp. 3–20.

Global Warming Research Center for Agriculture and Fishery (2008) *2008–2010 Pilot Project on Production Area Structural Reform to Cope with Global Warming (Chikyu ondanka taio sanchi kozo kaikaku moderu jitsho jigyo)* (Miyazaki: Global Warming Research Centre for Agriculture and Fishery).

Hokkaido Agricultural Policy Department (2009) *Documents about rice (Komeni kansuru shiryo).* http://www.pref.hokkaido.lg.jp/NR/rdonlyres/D227E5FF-779B-4B0F-A390-B46CD3BF89AC/0/komenikansurusiryou2010.pdf, date accessed November 18, 2010.

S.M. Howden, J. Soussana, F.N. Tubiello, N. Chhetri, M. Dunlop and H. Meinke (2007) 'Adapting agriculture to climate change', *Proceedings of the National Academy of Sciences of the United States of America*, 104, 50, 19691–19696.

S. Huq and H. Reid (2007) Community-Based Adaptation: A Vital Approach to the Threat Climate Changes Poses to the Poor, Briefing of International Institute for Environment and Development, http://pubs.iied.org/17005IIED.html, date accessed December 30, 2012.

IPCC (2001). *Climate Change 2001: Impacts, Adaptation and Vulnerability. IPCC Third Assessment Report* (Cambridge, New York, Oakleigh, Madrid, Cape Town: Cambridge University Press).

Japan Meteorological Agency (2012a) Weather Statistics Information Mean Value of Past Meteorological Data in Niigata (*Kisho Tokei Jyoho, Kakono Kishodeta Kensaku, Heinenchi, Niigata*), http://www.data.jma.go.jp/obd/stats/etrn/view/nml_sfc_ym.php?prec_no=54&prec_ch=%90V%8A%83%8C%A7&block_no=47604&block_ch=%90V%8A%83&year=&month=&day=&elm=normal&view=, date accessed December 30, 2012.

Japan Meteorological Agency (2012b) Weather Statistics Information Mean Value of Past Meteorological Data in Miyazaki (*Kisho Tokei Jyoho, Kakono Kishodeta Kensaku, Heinenchi, Miyazaki*), http://www.data.jma.go.jp/obd/stats/etrn/view/nml_sfc_ym.php?prec_no=87&block_no=47830&year=&month=&day=&view=, date accessed December 30, 2012.

MAFF, Japan (2007) *Climate Change Adaptation Report by Item (Hinmokubetsu chikyu ondanka tekiousaku report)* (Tokyo: MAFF, Japan).

MAFF, Japan (2008) *Comprehensive Strategy to Global Warming Provision by MAFF (Norinsuisansho chikyu ondanka taisaku sogo senryaku)* (Tokyo: MAFF, Japan).

MAFF, Japan (2009) Status of Planted Rice Variety in Fiscal Year 2009 *(Heisei 21 nendo suiko uruchimai hinsyubetsu sakutsuke jyokyo ni tsuite),* http://www.syokuryo.maff.go.jp/archives/data/21kome-sakutsuke.pdf, date accessed November 19, 2010.

MAFF, Japan (2010a) Result of Rice Inspection *(Komeno kensa kekka),* http://www.maff.go.jp/j/ soushoku/syoryu/kensa/kome/index.html, date accessed September 2, 2010.

MAFF, Japan (2010b) About MAFF global warming task force *(Nourinsuisansho ondanka taisaku honbu ni tsuite)*, http://www.maff.go.jp/j/press/kanbo/kankyo/091026.html, date accessed September 24, 2010.

Miyazaki Prefecture (2012) Third Miyazaki prefecture global warming countermeasure implementation plan *(Dai 3ki Miyazaki kencho chikyu ondanka taisaku jikko keikaku)*, http://www.pref.miyazaki. lg.jp/ parts/000166955.pdf, date accessed December 27, 2012.

National Agricultural Research Centre for Tohoku Region (2006) *Annual Report 2006* (Iwate, Japan: National Agriculture Research Center for Tohoku Region).

Niigata Prefecture (2006) *Agriculture and Fishery Vision 2006 (Norin suisan vision 2006)*, (Niigata: Niigata Prefecture).

Niigata Prefecture (2009a) *Niigata Global Warming Regional Countermeasure Promotion plan 2009 (Niigataken chikyu ondanka taisaku chiiki suishin keikaku 2009)*, (Niigata: Niigata Prefecture).

Niigata Prefecture (2009b) *Dream developing policy plan (Yume okoshi seisaku plan)*, (Niigata: Niigata Prefecture).

OECD (2010) *OECD Environmental Performance Reviews: Japan 2010* (Paris: OECD Publishing).

K. Ouchi (2010) *Rice Prefecture Niigata Crying for Hot Summer (Komedokoro Niigata, mousho ni naku)* (Tokyo: Asahi Shinbun Press), at October 9, 2010.

Pacific Consultants Co LTD (2010) *Project Report of Reviewing and Supporting Climate Change Adaptation Vision (Kikohendo tekio shishin kento shien chosa itaku gyomu)* (Tokyo: Pacific Consultants Co LTD).

B. R. Regmi (2012) 'Revisiting Community-based Adaptation', *Forestry Nepal*, http://www.forestrynepal.org/publications/article/5643, date accessed December 31, 2012.

H. Reid, S. Huq and L. Murray (2010) *Community Champions: Adapting to Climate Challenges* (London: International Institute for Environment and Development)

H. Seino (2008) *Global Warming and Agriculture (Chikyu Ondanka to Nougyou)* (Tokyo: Seizando Press).

K. Yamashita (2009) 'There is no Agricultural Reform Because of JA (Nokyo ga arukara nosei kaikaku ga dekinai)', Research Institute of Economy, Trade and Industry, http://www.rieti.go.jp/jp/papers/contribution/yamashita/61.html, date accessed August 18, 2010.

M. Yokozawa and T. Iizumi (2009) 'Chapter 5 Rice Yield' in Project Team for Comprehensive Projection of Climate Change Impacts (ed.) S4 Second

Report: Global Warming Impacts on Japan; Long-term Climate Stabilisation Levels and Impact Risk Assessment, http://www.nies.go.jp/s4_impact/pdf/S-4_report_2009eng.pdf, date accessed December 27, 2012.

Abbreviations

CC	climate change
GHGs	greenhouse gases
JA	Japan Agricultural Cooperatives
JMA	Japan Meteorology Agency
MAFF	MAFF (Japan)
MEXT	Ministry of Education, Culture, Sports, Science and Technology (Japan)
	MLIT
	Ministry of Land, Infrastructure and Transport

MOE	Ministry of the Environment (Japan)
OECD	Organisation for Economic Co-operation and Development