8 Quality Growth Focusing on Resilience to Disaster Risks

Enhancing resilience against disasters is a fundamental attribute of quality growth. Disasters can be classified into four major categories (Sawada 2007). As set out by Aldrich et al. (2015), the first category is comprised of natural disasters including geophysical disasters (earthquakes, tsunamis and volcanic eruptions), meteorological disasters (storms or typhoons), hydrological disasters (floods), climatological disasters (droughts), and biological disasters (epidemics and insect infestations). The second category of disasters is comprised of technological disasters, such as transport accidents (including air, rail, road and water transport) and industrial accidents (chemical and oil spills, nuclear power plant meltdowns, industrial infrastructure collapse). The remaining two disaster types are manmade disasters, including economic crises (currency crises, hyperinflation, and banking crises) and disasters involving the use of violence (such as terrorism, civil strife, riots, and civil and external wars) (2).

This chapter mainly discusses those from the first category: hydrological, meteorological, climatological, and geophysical disasters with particular regard to the concept of resilience. The United Nations Office for Disaster Risk Reduction (UNISDR) (2009) defines "resilience" in regard to these types of disasters as "The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions" (UNISDR 2009, 24).

Quality growth is expected to enable people and society to strengthen resilience and transform their economy, making it more resilient. The outcome document of the United Nations summit for the adoption of the post-2015 development agenda, "Transforming Our World: the 2030 Agenda for Sustainable Development," includes Goal 9 as the need to "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation," while Goal 11 sets out the need to "Make cities and human settlements inclusive, safe, resilient and sustainable." More specifically, one of the targets of Goal 11 is to, "By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels."

Disaster risk reduction (DRR) enables both quality growth and human security. During the world conference that adopted the Sendai Framework for DRR, states reiterated their commitment to addressing disaster risk reduction and the building of resilience to disasters with a renewed sense of urgency within the context of sustainable development and poverty eradication. They also pledged to integrate, as appropriate,

A. Hosono, *SDGs, Transformation, and Quality Growth*, Sustainable Development Goals Series,
https://doi.org/10.1007/978-981-16-9748-7_8

both disaster risk reduction and the building of resilience into policies, plans, programs and budgets at all levels and to consider both within relevant frameworks (United Nations Office for Disaster Risk Reduction 2015, 1). Indeed the Sendai Framework for DRR added a policy of simultaneously reducing poverty while addressing disaster risks by engaging in disaster risk reduction with a focus on economic development.

Towards Reconstruction: Hope Beyond the Disaster, a report by the Reconstruction Design Council in Response to the Great East Japan Earthquake and Tsunami 2011 highlights seven principles for the reconstruction framework. They are fundamental concepts for resilience enhancing quality growth. The first principle is: "For us, the survivors, there is no other starting point for the path to recovery than to remember and honor the many lives that have been lost. Accordingly, we shall record the disaster for eternity, including through the creation of memorial forests and monuments, and we shall have the disaster scientifically analyzed by a broad range of scholars to draw lessons that will be shared with the world and passed down to posterity." Further, among others, the report highlights the importance of "community-focused reconstruction" (Principle 2); "forms of recovery and reconstruction that tap into the region's latent strengths and lead to technological innovation" (Principle 3); and the need to "simultaneously pursue reconstruction of the afflicted areas and revitalization of the nation" (Principle 5).

Disaster risk reduction and enhancement of the resilience of people and society are critical for quality growth, especially for sustainable growth and inclusive growth, as well as poverty reduction through such growth. Working on disaster risk reduction in advance reduces the level of damage caused by a disaster. Such approaches are "more cost-effective when compared with the cost required for post-disaster recovery and reconstruction. As a result, it also leads to sustainable economic growth" (JICA 2017, 2). Ishiwatari (2016) cites studies that confirm high cost-effectiveness of investment in disaster risk reduction: the benefit–cost ratio of 4 was the average of 4,000 disaster risk reduction programs in the United States; the ratio was 1–17 in cases of flood control investments in 7 countries; the ratio was 3.3 in cases of investments for comprehensive flood control in Tokyo, Osaka, and Nagoya (13). Furthermore, it should be emphasized that much of the suffering caused by disaster damage affects low-income and vulnerable people and communities. Disaster takes away their means of livelihood and prevents them from breaking out of the poverty trap (JICA 2017). Therefore, disaster risk reduction is crucial for poverty reduction and for growth to be inclusive so as not to leave anyone behind.

Regarding concrete actions for disaster risk reduction, the Sendai Framework for DRR focuses on four priority areas for action, as follows.[1] Priority 1: Understanding disaster risks; Priority 2: Strengthening disaster risk governance to manage disaster risk; Priority 3: Investing in disaster risk reduction for resilience; and Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction (United Nations Office for Disaster Risk Reduction 2015, 14). This chapter discusses experiences related to these priority areas in the Central American region, one of the most vulnerable regions in the world, as well as Chile, Peru, and Japan (Sects. 8.1, 8.2, 8.3 and 8.4). Following this, concluding remarks will be provided.

8.1 Understanding Disaster Risks

In order to improve the understanding of disaster risks, the Sendai Framework for DRR emphasizes that "Policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. Such knowledge can be leveraged for the purpose of pre-disaster risk assessment, for prevention and mitigation and for the development and implementation of appropriate preparedness and effective response to disasters" (United Nations Office for

Disaster Risk Reduction 2015, 14). In this regard, one of the most important lessons that Japan learned from the Great East Japan Earthquake and Tsunami was the realization of the big gap between the required capacity of the country, society and people to cope with the disaster, and the actual capacity. The magnitude of this gap determines the damage caused by disasters.

Based on case studies, Ejima (2012) assumes that there are three kinds of required capacities to be considered depending on the severity of the disasters we face.[2] The first one is the capacity for a scenario disaster. A "scenario disaster" refers to a disaster that is of a predicted magnitude and for which preventive measures have been taken in advance. However, the capacity that a society actually has can sometimes be smaller than what is required to cope with these kinds of predicted "scenario disasters." This gap is called a Type 1 gap. The second gap, known as a Type 2 gap, is the gap between the actual capacity a society has and the required capacity to cope with a disaster of which the magnitude happens to exceed the foreseen "scenario disasters." The last of these, the Type 3 gap is the gap between the actual capacity a society has and the capacity level that has to be enhanced over time to deal with the long-term changes that happen due to factors such as climate change, urbanization, population growth, etc.

A basic approach to enhance the capacity to address the three types of gap is learning and learning to learn. Indeed resilience is "about learning to live with the spectrum of risks that exist at the interface between people, the economy, and the environment" (Global Facility for Disaster Reduction and Recovery (GFDRR) and World Bank 2015, 12). The United Nations Office for Disaster Risk Reduction (UNISDR) defines capacity development as "the process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions." It notes that "capacity development is a concept that extends the term of capacity building to encompass all aspects of creating and sustaining capacity growth over time. It involves learning and various types of training, but also continuous efforts to develop institutions, political awareness, financial resources, technology systems, and the wider social and cultural enabling environment" (UNISDR 2009, 6). In this section, I will discuss capacity development (CD) to address the three types of gap, with reference to the above definition of CD.

Against the Type 1 gap, which is concerned with the difference between recognition and reality, strengthening "risk literacy" could be an effective approach. In many cases, people make judgments on their own and do not make the effort to evacuate. It is important to establish adequate communication at various levels in order to minimize this type of gap. For instance, it is necessary to understand the limitations of structural and non-structural measures. While one of the important roles of the public administration is to make residents feel safe, it is also important to make them aware of the limitations of such measures so that they can properly anticipate the risk of disaster. Communication is essential to ensure this awareness. There are cases seen frequently around the world where people's sense of crisis suddenly disappears, especially after the construction of large-sized structures such as embankments. However, there are limitations to any kind of measure. It is essential to improve people's disaster-reaction capacity by spreading this kind of information throughout the community.

The Type 2 gap is caused because anticipating risk always involves uncertainty. This shows the importance of "redundancy," such as building a multi-layered or combined capability for reacting to disasters. In various regions throughout the world, including Japan, people may develop a very strong sense of security with the introduction of a system based on leading-edge technology. However, we must also be aware of the limitations of such systems. When the Great East Japan Earthquake occurred, there were situations where information could not be transmitted because of a blackout. It is important to remember that there are many kinds of potential risks, and sometimes "apparently redundant" preventive measures may become necessary.

They may appear redundant, but in fact they are necessary. Another method that can also be effective is to establish multi-purpose measures by adding disaster prevention to projects in different areas that are not originally aimed at disaster prevention. We should therefore not ignore redundant measures and operations for future disaster risk management due to the Type 2 gap. In learning from the East Japan Earthquake and other experiences, we should be better prepared with as many alternatives as possible by designing and operating preventative measures. To do so, we had better consider the importance of multi-functional and multi-sector disaster risk management. We could call this approach "redundancy."

Lastly, regarding the Type 3 gap, we need to recognize that even if we institute measures based upon an expected situation, such measures may not provide a permanent solution, as circumstances can change daily. For example, with the recent discussions in the international community regarding climate change and its impacts, we need to continue reviewing various countermeasures, taking into account changing factors such as the rate and extent that the climate is changing, urbanization, and social factors. In order to address this type of gap, an effective measure could include efforts toward continuous improvement or a kind of "Kaizen" approach.

Various kinds of disaster prevention measures have been implemented in many countries. However, disasters such as the Great East Japan Earthquake demonstrate the fact that various countermeasures may not necessarily work as expected and may not result in the reduction of risk. In order to fill the various gaps explained so far, to plan effective disaster countermeasures and implement better disaster risk management, reliable risk assessment based on scientific analysis is needed.

8.2 Strengthening Disaster Risk Governance to Manage Disaster Risk

The Sendai Framework states that strengthening DRR for prevention, mitigation, preparedness, response, recovery and rehabilitation is necessary and fosters collaboration and partnership across mechanisms and institutions for the implementation of instruments relevant to disaster risk reduction and sustainable development. In order to mainstream and integrate risk reduction, the Sendai Framework emphasizes the importance of (1) addressing disaster risk in publicly owned, managed or regulated services and infrastructures, (2) promoting and providing incentives, (3) enhancing relevant mechanisms and initiatives for disaster risk transparency, and (4) putting in place coordination and organizational structures (United Nations Office for Disaster Risk Reduction 2015, 17). The "Disaster Countermeasures Basic Act" in Japan states that disaster risks should be managed and reduced comprehensively through the vertical roles of the national and local governments, the horizontal role of society across the whole area, and collaboration with other stakeholders such as the private sector, NGOs and local communities (JICA 2017, 9).

Regarding the first and second priorities of Sendai Framework for DRR, understanding disaster risks and strengthening disaster risk governance, experiences of international cooperation for disaster risk management in Central America could be highly relevant, as shown in Case 8.1. The Central American region is very prone to natural disasters due to frequent hurricanes, earthquakes, and volcanic activities. For example, 88.7% of the territory of El Salvador is considered to be a high-risk area for disasters, and 95.4% of the population are living in high-risk areas (World Bank 2005).

8.2.1 Case 8.1: Capacity Development for Disaster Risk Management in Central America: BOSAI Initiatives[3]

8.2.1.1 Central American Policy of Integrated Risk Management (PCGIR) and BOSAI Project

Central America is a disaster-prone region and the countries of the region have been making concerted efforts to reduce disaster risks through a regional cooperation mechanism of the Center of Coordination for the Prevention of Natural Disasters in Central America (CEPREDENAC). One of the projects based on the above-mentioned approaches discussed in Sect. 8.1 is the Project on Capacity Development for Disaster Risk Management in Central America, or the "BOSAI Project." In this project, JICA supports capacity development (CD) to promote community-based disaster risk management in six countries in Central America through a region-wide cooperation framework under CEPREDENAC, which itself is one of the specialized regional cooperation mechanisms under the auspices of the Integration System of Central America (SICA).

The overall framework for this region-wide cooperation initiative was established in the Tokyo Declaration of Japan-SICA Summit in 2005. It included a region-wide cooperative effort for the fight against Chagas disease,[4] better mathematics education, natural-disaster prevention, improved reproductive health, quality and productivity improvements, and other initiatives. The governments of Costa Rica, Honduras, Guatemala, El Salvador and Panama submitted official requests to Japan for technical cooperation with regard to local disaster risk management in 2006. Based on this initiative, management authorities of the above five countries, CEPREDENAC and JICA launched the "BOSAI Project" in 2007. Nicaragua later joined the project in 2008.

The heads of states of member countries of SICA adopted, on October 30, 2010, the Central American Policy of Integrated Disaster Risk Management (PCGIR), in order to respond to the need to update the regional commitments designed to reduce the risk and enhance prevention of disasters and thereby contribute to an integrated vision of development and security in Central America. The PCGIR highlights the importance of developing local capacity to reduce risk and to respond to disasters by strengthening the autonomy and resilience of communities. BOSAI has constituted an important pillar in the implementation of the PCGIR.

8.2.1.2 Understanding Disaster Risks and Capacity Development (CD) to Reduce Vulnerability

The regional progress report of the Hyogo Framework of Action (HFA) on Central America, updated April 2011, referenced two indicators for HFA priorities in relation to local disaster risk management: "Sub/regional early warning systems exist" and a "Sub/regional information and knowledge sharing mechanism is available." One of the aspects which should be highlighted among the achievements of BOSAI is its contribution to the progress towards achieving these regional indicators of HFA (BOSAI Terminal Evaluation Team 2012, 9).

In this regard, BOSAI's approach to these indicators could be reviewed from the three perspectives discussed in Sect. 8.1. In terms of "Risk Literacy," BOSAI focused on helping the residents fully understand the risks for their own community and taking actions on their own by maintaining reliable communication between the communities, municipalities and national agencies. At the same time, it empowered the communities themselves to implement risk mapping through repeated discussions and site inspections.

From the perspective of "redundancy," BOSAI approached other sectors through activities to promote the awareness of disaster prevention by means of school education, and by incorporating methods of collaboration with the development committees of the communities.

In terms of the Kaizen approach, BOSAI implemented capacity development (CD) programs aiming to let the community prepare risk maps and disaster management plans, and improve them on its own. Capacity development (CD), both at the community and local government levels, strengthened their ability to effectively respond to various disasters including earthquakes, flooding and landslides and to take concrete action such as the development of hazard maps, early warning systems, disaster prevention plans, and innovative practices to prevent landslides, flooding, etc.

According to the Terminal Evaluation Report of BOSAI, reduction of vulnerability to disasters in target communities (the first target) and reduction of vulnerability to disasters in target municipalities (the second target) were 68% and 90% achieved, respectively. As regards improvement of knowledge and ownership of local disaster risk management of national institutions (the third target), the target was achieved fully in three national institutions and significant advances were attained in three other national institutions (BOSAI Terminal Evaluation Team 2012, 10–11).

The first target of BOSAI was related directly to the communities' capacity development (CD). There have been many important cases of successful capacity development in which effective mutual learning and co-creation of innovative solutions have taken place. One of the most outstanding cases could be that of used-tire dikes. Major achievements at the community level included the development of organizations, risk maps, evacuation routes, early warning systems and emergency response plans. Some communities in Panama, Costa Rica, Honduras and El Salvador constructed small mitigation works such as used-tire dikes and retaining walls, as well as demonstrating remarkable involvement and commitment through voluntary labor. As the experience of constructing of new dikes with used tires was almost completely new and innovative, a very careful approach was adopted. It was decided to first carry out a pilot project in order to establish the proper methods of design and construction. Community members participated in the construction work in shifts. These decisions were made by community members. In the BOSAI Project, there were several other cases of the co-creation of innovative low-cost solutions to reduce the vulnerability to disasters in the target communities and to strengthen their disaster preparedness. Installation of rainfall equipment (rain gauges, fluviometers) with alarm units for community-operated flood warnings and water glasses (water level monitors) with automatic warning systems are some examples of this.

According to the evaluation of the strengthening of the mechanisms for disaster risk management, based on interviews conducted in 50 communities out of the target 62 communities of the BOSAI project, 96% established a disaster risk management organization, 88% prepared a risk map, 66% set-up communication systems, and 88% developed a disaster response plan. Regarding the promotion of knowledge or awareness on disaster risk management in target communities, 66% held workshops or events in communities and 60% conducted evacuation drills.

Based on the experiences of the targeted communities, national scale-up processes have taken place in each country. The installation of rain gauges for early flood warning extended beyond the targeted communities in El Salvador. A plan to set up warning sirens in more than 150 communities is being implemented in Tegucigalpa, Honduras. The Frog Caravan is one successful activity of the BOSAI Project in that the practice extends well beyond the target communities.[5] The Frog Caravan was also conducted by other donors. A plan to extend the Frog Caravan nationwide has been implemented in Guatemala and Panama.

8.2.1.3 The Impact of the BOSAI Project in Reducing Vulnerability of Communities and Municipalities

The impact of the BOSAI project has been recognized in some natural disaster events. When Hurricane Ida slammed into El Salvador in November 2009, it triggered massive flooding and landslides and more than 300 people were killed or went missing. However, in the coastal village of Las Hojas, there were no deaths and an investigation attributed this at least partly to the fact that a disaster early warning system had been installed there by the BOSAI project.

In the very early morning of November 8, the disaster committee of San Pedro Mashuat received the information of extraordinary rainfall with water levels beginning to rise dangerously from the upstream communities of the Jiboa River. This information was transmitted to the village disaster prevention committee of Las Hojas via a JICA-donated wireless system. Nine alarm sirens were sounded throughout the village two hours before the flood allowing local residents to flee quickly before floodwater could engulf them. The establishment of disaster prevention committees and the installation of wireless transmission systems and nine alarm sirens were part of the BOSAI project. A survey conducted in 2010 discovered that 50% of 94 families of the community evacuated when they heard the siren and that 37% knew about the BOSAI Project. During tropical depression 12E in October 2011, there were no casualties in the BOSAI Project target areas in El Salvador. When another survey was conducted in December 2011 in San Pedro Mashuat, where significant damage occurred during storm 12E, inhabitants expressed their gratitude to the BOSAI Project that there were no casualties thanks to the early evacuation practice (BOSAI Terminal Evaluation Team 2012, 13).

In February 2011, one of the pioneer municipalities of the BOSAI Project in El Salvador, Santa Tecla participated as the sole local government representative community of Central America in the Thematic Debate of the United Nations General Assembly on Disaster Risk Reduction. The discussion aimed to strengthen the understanding of how to reduce risk and exposure to disasters through effective investment policies and practices and sustainable urban management. Santa Tecla received recognition as the "Role Model for Participatory and Sustained Risk Reduction Policy" of the "Making Cities Resilient Campaign" in the Third Session of the Global Platform for Disaster Risk Reduction, organized by the United Nations in Geneva in May 2011.

According to the Mayor of Santa Tecla, Oscar Ortiz, the keen awareness and motivation of this municipality toward disaster prevention is due to the tragic consequences of a landslide caused by the big earthquakes of 2001. The landslide took the life of 700 inhabitants. It was difficult to reconstruct communities severely affected by the earthquakes. The municipality has placed the highest priority on disaster risk management since this tragedy occurred. The mayor considers the key to the successful process, recognized by the United Nations, was the trust of the inhabitants through a participatory approach, education and local government leadership with a medium and long-term vision. Santa Tecla's experiences and know-how have been shared with other Central American countries. The BOSAI Project has been effective and the municipality learned a lot from the Hyogo Phoenix Plan.[6]

8.2.1.4 Strengthening Disaster Risk Governance to Manage Disaster Risk

Several national scale-up initiatives to strengthen disaster risk governance based on the BOSAI project have been carried out. In El Salvador, the Civil Protection Authority has assigned 178 municipal delegates and 19 department delegates in accordance with the Law of Civil Protection, Prevention and Mitigation of Disasters enacted in 2005. These delegates facilitated the establishment of the Municipal Commission of Civil Protection (CMPC). The National System of Civil Protection (SINAPROC) in Panama has increased the number of staff at a provincial level with the assignment of a national agent and provincial agent, who are engaged in the coordination with municipalities/communities to promote integrated local disaster risk management. The Permanent Commission of Contingencies (COPECO) of Honduras, through its seven regional offices, is promoting the establishment of Emergency Committees at different levels (departments, municipalities, communities, schools and working centers). The BOSAI Project has been contributing to the institutional strengthening of these organizations through activities specifically targeting municipalities and communities. National legal and/or regulatory frameworks related to disaster risk reduction have been established and strengthened (for details, see Hosono 2012).

Exchanges of experiences, knowledge and know-how related to disaster risk management among member countries have been actively promoted through CEPREDENAC. The capacity of CEPREDENAC itself has been strengthened during the BOSAI Project. In the BOSAI Project, methodologies and tools commonly applicable in Central America were developed based on the different experiences of member countries, producing a series of practical materials including a manual of hazard-map based trainings, manuals on the production and use of a rain gauge and water glass, construction guides for used-tire or soil–cement dikes, prevention kits for disasters caused by volcanic eruptions, Frog Caravan manuals, a disaster simulation game, SAT (*Sistema de Alerta Temprana*, or early warning system) guidebooks and so on, which have been made publicly available in member countries.

8.3 Investing in Resilience: "Build Back Better" in Recovery, Rehabilitation and Reconstruction

Regarding the characteristics of investment in disaster risk reduction, the Sendai Framework for DRR highlights that "Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost-effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation" (United Nations Office for Disaster Risk Reduction 2015, 18). For disaster preparedness and build back better, the Sendai Framework states that "Disasters have demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of a disaster, is a critical opportunity to 'Build Back Better', including through integrating disaster risk reduction into development measures, making nations and communities resilient to disasters" (United Nations Office for Disaster Risk Reduction 2015, 21).

Cases 8.2 and 8.3 contain multiple insights from the afore-mentioned concepts of the Sendai Framework. Case 8.4 provides an effective approach to build back better, summarizing reconstruction experiences after major earthquakes and the tsunami in Japan with the use of "land readjustment."[7]

8.3.1 Investing in Low-Cost Earthquake-Resistant Housing to Enhance the Resilience of Low-Income Families and Communities

El Salvador was devastated by two successive earthquakes on January 13th (magnitude 7.6) and February 13th (magnitude 6.6), 2001, which resulted in the deaths of over 1,000 people, along with extensive damage to buildings—especially the houses of low-income communities. According to one study of these two large earthquakes (Saito 2012), 60% of destroyed houses were those of poor people whose income was less than twice the country's minimum wage. Total damage amounted to 16 billion dollars, or 12% of GDP of the country. Half of all hospitals, one-third of schools and even the Office of the President were affected.

In all countries, it is necessary to invest in disaster risk reduction for resilience to enhance disaster preparedness for an effective response and to build back better in recovery, rehabilitation and reconstruction. However, in developing countries particularly, both the fiscal and other constraints of government and the low incomes of the most vulnerable inhabitants of the country need to be fully taken into account. Therefore, it should be emphasized that technologically and financially feasible options are essential for developing countries. From this point of view, the low-cost earthquake-resistant housing (Taishin) initiatives in El Salvador are a way to address this issue. Case 8.2 elaborates on these initiatives.

8.3.1.1 Case 8.2: Technological Innovation and Capacity Development for Low-Cost Earthquake-Resistant Housing: Taishin Initiatives

Taishin initiatives were aimed at furthering earthquake-resistant housing in El Salvador from 2003 to 2012. JICA started a cooperation project for earthquake disaster prevention in

Mexico with the National Center for Disaster Prevention (CENAPRED) after the big earthquake in the central part of Mexico in 1985, which killed about 10,000 people. The technology and innovative methods developed by the project have since been used in the Taishin Project.

The launch of the Taishin Project in 2003, two years after the two great earthquakes in El Salvador, was timely because in the following year the government of El Salvador introduced the "Safe Country: Plan of Government of El Salvador 2004–2009," which advocated for the adequate provision of housing with clear government roles in tackling the challenge. This included the formulation of a new housing policy, strengthening of housing standards and regulations, a new loan scheme for the informal sector, and a land entitlement, especially for the poor. The launch of the five-year "Safe Country" plan, which emphasized housing issues, further enhanced the policy-relevance of the Taishin initiative (Saito 2012).

In El Salvador and other Central American countries, adobe (sun-dried brick) houses are popular among low- and middle-income earners. These houses are vulnerable to earthquakes and many of them were completely or partially destroyed by two major earthquakes in 2001 in El Salvador. Houses made of improved adobe, soil–cement, block panels, and concrete blocks were tested with their respective appropriate structures in large structure laboratories at the National University of El Salvador and the Jose Simeon Cañas University of Central America (UCA). Among other goals, the Taishin Project aimed to establish official technological standards for earthquake-resistant houses and achieve institution-building for the governmental urban and housing development agency in charge of housing policies and construction permits. As a result, according to a JICA (2017) report, "a legally backed architectural technology standard was enacted in 2014. In El Salvador, structural calculations have been used to confirm safety for low- or middle-income earners in most cases. The new technological standard does not require structural calculations, it regulates only the specification code. It is expected to be used to design and build small houses. The project has also provided opportunities to raise the awareness of highly quakeproof houses. The 'Build Back Better' project, based on the experience of the earthquake in 2001, is steadily being implemented" (13). Subsequently, the experiences and innovation from the joint Taishin Project CENAPRED/JICA/Japan Institute of Construction/El Salvador were shared throughout Central America. The following lists the major accomplishments of the Taishin project, as highlighted by Saito (2012, 181–182):

> First of all, the initiative has undertaken all the planned activities for the transfer and adaption of Taishin assessment techniques to major national institutions, including the National University of El Salvador and the UCA. Now, these two universities are capable of undertaking the scientific seismic capacity assessments using the equipment and facilities provided by Japan. Through the Taishin experiment, the laboratories of two universities in collaboration with El Salvador Foundation for Development and Dissemination of Housing (FUNDASAL) has already finished testing four low-cost housing construction methods. It is also noteworthy that in 2012, both of these universities newly established a Master's Program for Earthquake Engineering, which takes advantage of the capacity and expertise the universities have built up through this Taishin initiative.
>
> Secondly and closely related to the first achievement, the project succeeded in refining four low-cost housing construction techniques to make them more earthquake resistant. In collaboration with FUNDASAL, the project undertook the experimental housing construction pilot, based on the refined quake-resistance methods. With regard to the soil-cement method, one of the four appropriate technologies for low-cost housing, the project improved the soil-cement by adding the locally available volcanic ash to soils. Furthermore, in collaboration with El Salvador's "Chagas' disease[8] project" with JICA assistance, the Taishin project also introduced cement plaster for adobes, which is effective in preventing the vector insect of Chagas' disease (kissing bugs) from encroaching into the walls and floors of the adobe houses. The introduction of such an improved technique for low-cost adobe methods, which is more quake-resistant and repellent to insects, would be particularly beneficial for low-income groups. Following the satisfactory results of the pilots, manuals and training materials on the quake-resistant construction methods were developed and distributed widely.

Thirdly, thanks to the successes in the capacity development of partner institutions, El Salvador has now started to play the role of a sub-regional pivotal country in the field of the Taishin technique, assisting Nicaragua, Dominican Republic, Haiti, among others.

8.3.2 Investing in Resilient Infrastructure for Resilient Cities and Human Settlements

According to the JICA document, *Disaster Resilient Society for All*, build back better is the concept of turning disasters into an advantage by creating a stronger country and society (JICA 2017, 14). This concept is based on many decades of Japanese experience. The same document explains that every time Japan is struck by a major disaster, it revises its existing related laws, regulations, and standards. This approach "enables various stakeholders to build a more disaster-resilient country based on more stringent standards. This attitude—seeing major disasters as opportunities to build more disaster-resilient communities—was referred to in the Sendai Framework as the concept of 'Build Back Better'" (JICA 2017, 2).

Cases 8.3 and 8.4 appear to be relevant as cases of investing in disaster risk reduction for resilience (Sendai Framework Priority for Action 3) and build back better (Priority for Action 4).

8.3.2.1 Case 8.3: Project for Capacity Development of the Department of Climate Change Adaptation and Strategic Risk Management for Strengthening of Public Infrastructure: GENSAI Initiatives

In an effort to support the risk-reduction efforts of El Salvador, a cooperation project called GENSAI (Phase 1) started in 2012. The tropical cyclone 12E seriously affected El Salvador in 2011, leading to historically high continuous rainfall, and causing severe damage to social and economic infrastructure in the country. Not only did 12 bridges collapse, but 37 bridges were damaged seriously, and landslides and road slope failures were observed at many sections along roads including major highways. Disasters caused by rain in El Salvador have become more frequent and serious recently. Hurricanes Mitch, Stan, Ida and Tropical Cyclone 12E all brought heavier continuous rainfall.

In these circumstances, the Department of Climate Change Adaptation and Strategic Risk Management (DACGER) was newly organized by the Ministry of Public Works, Transport, Housing and Urban Development (MOP) of El Salvador under the Minister's direct control in 2008. With this initiative, the government of El Salvador made the promptest response to climate change among Central American countries. With these provisions, government efforts proved highly capable during the restoration works following 12E. Heavy equipment consisting of 142 heavy machines for reconstruction was granted by the Japanese government in 2010 and was effectively utilized during the restoration work. With this experience and in response to a request from the MOP, the Japanese government decided to implement the Economic Infrastructure Rehabilitation Project in 2012. Almost concurrently, in order to strengthen the capacity of disaster reduction through pre-disaster investments and seismic reinforcement construction, the GENSAI Project commenced with the cooperation of JICA.

The aims of the GENSAI Project carried out between 2012 and 2015 in El Salvador were: (1) to establish a structure in the MOP which promotes the implementation projects of improvement of public infrastructure in accordance with the priority recommended by DACGER; (2) to establish a system which rapidly and adequately prepares an inventory of damage and implements reconstruction work when natural disasters occur; and (3) to establish a national training system for national engineers in charge of public infrastructure.

The GENSAI Project includes grant provisions for equipment and technical cooperation for the reinforcement of public infrastructure for climate change adaptation as well as education for disaster prevention.

The GENSAI Project Phase II has been implemented from 2016 to 2021. It aims to (1) improve risk diagnosis ability against earthquakes for road infrastructure (bridges, road slopes); (2) formulate standard specifications, design guides, and cost estimation standards for road disaster risk reduction projects; (3) enhance DACGER's project management capacity on road disaster risk reduction projects; and (4) share with other countries project outcomes from disaster risk diagnoses and road disaster risk reduction projects (JICA and MOP 2019).

In this way, a more comprehensive approach to disaster risk management has been adopted in El Salvador. The goal of the GENSAI Project is to strengthen the infrastructure to protect the lives and livelihoods of inhabitants. BOSAI, TAISHIN, and GENSAI Projects are expected to produce synergistic effects enhancing the capacity and resiliency of people and society to address the risk of natural disasters, in ways that are much more integrated and effective.

8.3.3 Post-disaster Reconstruction to Enhance Resilience of Communities, Cities, and Society: Building Back Better Through Land Readjustment

After a disaster occurs, people aim to build back more resiliently and stronger than before ("building back better"), rather than simply trying to rehabilitate the disaster-stricken communities (see Yanase 2018). In post-disaster reconstruction, both preservation/cohesion and stronger resilience of communities are essential. In these regards, "a driving force behind the post-disaster reconstruction is land adjustment" (Yanase 2018, 63). As explained in Chap. 6, the usage of land readjustment in Japan is broad in scope and purpose. Post-disaster reconstruction is one of the five categories that delineate the purposes of land readjustment, together with control of urban sprawl, development of new towns, urban rehabilitation, and development of complex urban infrastructure (de Souza 2018, 23–24). As discussed in Chap. 6, land readjustment is an approach that can contribute to making cities more inclusive, safe, resilient, and sustainable. Moreover, it should be emphasized that, in addition to the standard scheme of land readjustment applicable to the five categories, innovative measures have been introduced to enhance the effectiveness and flexibility of land readjustment for post-disaster reconstruction. We can acknowledge the effectiveness of these approaches during the reconstruction process after the two great disasters in the last few decades in Japan: the Great Hanshin-Awaji Earthquake and the Great East Japan Earthquake and Tsunami.

8.3.3.1 Case 8.4: Reconstruction After the Great Hanshin-Awaji Earthquake and Great East Japan Earthquake and Tsunami Through Land Readjustment and Its Further Innovation

Yanase (2018) summarizes the damage resulting from these two disasters and the subsequent innovative measures introduced in the form of a standard land readjustment scheme during the reconstruction process.[9] On January 15, 1995, the Great Hanshin-Awaji Earthquake occurred with a magnitude of 7.3. The earthquake occurred directly beneath Kobe, causing widespread destruction across the Kinki area (Hyogo Prefecture in particular, along with Osaka and Kyoto). The urban area of Kobe, one of the major cities of Japan, suffered significant damage. The earthquake left 6,437 people dead or missing, and 43,792 injured. A total of 460,000 households suffered damage; 104,906 houses were completely destroyed. Kobe, the most severely damaged city, conducted post-disaster reconstruction projects, including public housing development for the sufferers and land readjustment.

The government responded swiftly to these reconstruction plans. The primary mechanism for land readjustment is known as "replotting." Replotting refers to the change of location, format and area of several plots of land to achieve a project's final scenario. On February 26, a little more than a month after the earthquake, the Act on Special Measures Concerning Disaster-Stricken Urban District Reconstruction was passed. This act enabled a special framework for land readjustment. For example, a joint-construction public apartment site can be designated in a project area in which landowners can get their replotted land and participate in the joint construction of the apartment if they so choose. In addition, the act provided a framework to offer a flat in an apartment instead of replotted land to the disaster-affected people who lost their houses and were left with the land as their only asset. Legally, when the replotted land is not offered, equity is paid. The new framework helped the disaster-affected people to restore their livelihoods by providing them with houses built by an implementation agency instead of money. It is expected that the framework will enable the disaster-affected people to move from temporary housing into their own houses relatively soon after a disaster, without increasing their financial burdens.

On March 11, 2011, a big earthquake off the Pacific Coast of Japan hit the eastern part of the country. The damage from the 9.0 magnitude earthquake and subsequent tsunami, said to be of a kind that hits about once every 1,000 years, was far more devastating than that caused by the Great Hanshin-Awaji Earthquake. According to the National Police Agency, official records confirmed that the Great East Japan Earthquake and Tsunami left 18,456 people dead or missing and 400,438 houses/buildings either completely or partially destroyed as of August 8, 2014. The number of evacuees totaled more than 400,000 immediately after the disaster, and 247,233 people as of July 10, 2014. Note, however, that these figures include evacuees from around the damaged Fukushima Daiichi Nuclear Plant due to the fear of radiation contamination. The direct damage of the earthquake is estimated to be around 16–25 trillion yen. According to an estimation by the World Bank, this was the worst economic damage from a natural disaster in the world's history.

The scale of the disaster was unprecedented. A plan that included measures to improve disaster prevention functions was prepared. Several post-disaster reconstruction projects concerning urban planning are being conducted, including large-scale site preparations to move the communities from lower ground close to the sea to higher ground, and most of these projects require the use of land readjustment. In the tsunami-affected areas, the majority of the buildings were swept away and many places looked like wastelands. Based on its experience in new town developments, the Urban Renaissance Agency (former Housing and Urban Development Corporation) employed a method that was not often used for existing urban areas. The method involved leasing all of the land necessary for construction work from the property owners at an early stage, instead of using provisional replotting to implement the project. It therefore tried to complete the project within the shortest possible time.

8.4 Sharing Knowledge and Innovative Solutions and Nurturing Human Resources for Disaster Risk Reduction

Knowledge, good practices, and innovative solutions to reduce disaster risks are valuable assets for each country and for the entire world. Sharing them and nurturing human resources in the field of disaster risk reduction while taking advantage of these assets is an effective approach to enhancing the resilience of people and society. For example, an affordable emergency warning system based on advanced information and communication technology (ICT), as well as other cutting-edge technologies, enables people to take actions to minimize disaster risks. Case 8.5 highlights the initiatives of establishing an Emergency Warning Broadcast System (EWBS), based on Integrated Services Digital Broadcasting-Terrestrial (ISDB-T). Enhancing disaster prevention awareness, which is crucial for stronger resilience, can be facilitated by innovative equipment. Case 8.6 refers to the introduction of earthquake simulation vehicles to Peru. Finally, Case 8.7 discusses the Kizuna project as a pioneering initiative to nurture human resources for disaster risk reduction.

8.4.1 Case 8.5: Integrated Services Digital Broadcasting-Terrestrial (ISDB-T) and Emergency Warning Broadcast System (EWBS)[10]

ISDB-T is a terrestrial digital broadcasting system developed in Japan. Its functions—such as emergency alert broadcasting, TV reception on mobile terminals, and data broadcasting—provide advantages in disaster responses and the provision of diverse services. Japan has made proactive efforts to provide comprehensive support for the overseas promotion of ISDB-T. As of December 2018, ISDB-T is being spread in Latin American and the Caribbean, Asia and Africa, and has been adopted in a total of 18 countries. In 2009, Peru became the first Spanish-speaking country to decide to adopt the Japanese system of terrestrial digital broadcasting. Currently, this system is being introduced and installed in to the country's major metropolitan areas. EWBS, one of the Japanese system's features, is a method for broadcasting urgent information via the television, using a special signal, in order to promptly convey information on disasters such as earthquakes and tsunamis. EWBS TV sets and mobile receivers automatically activate when earthquakes and tsunamis happen, and this raises the alarm among the people. In the case of Japan, once a disaster occurs, the Japan Meteorological Agency releases disaster information, then broadcasters transmit the information via a special signal to TV sets and mobile receivers. Peru became the first country in Central and South America to make practical use of the EWBS. Peru is expected to serve as a leader in the spread of digital terrestrial broadcasting and the EWBS, and engage in independent efforts, such as sharing its experience with other countries adopting the terrestrial digital system in the region (MOFA 2019, 20–22).

8.4.2 Case 8.6: Disaster-Prevention Training with Earthquake Simulation Vehicles[11]

Japan has been supporting Peru in reducing its disaster risk for nearly 40 years. JICA comprehensively supports Peru in its disaster management cycle of evaluation, prevention, mitigation, preparation, response, rehabilitation, and reconstruction. JICA also works with organizations that scientifically analyze earthquakes and provide data to the government. A public awareness campaign is also carried out to explain the risks of earthquakes to junior high schools and elementary schools in comprehensible terminology (JICA 2016).

In principle, the Centro de Sensibilización y Aprendizaje sobre Terremotos y Tsunamis (Center for Sensitization and Learning on Earthquakes and Tsunamis, CESATT) of the Japan-Peru Center for Earthquake Engineering and Disaster Mitigation (CISMID) at the University of Engineering (UNI) carries out activities such as creating teaching materials and developing programs for disaster-prevention education and providing enlightenment workshops and training. Various Japanese know-how is being applied in these activities. CISMID began implementing disaster-prevention trainings of earthquake experiences, using earthquake simulation vehicles from 2018. Most of the participants in these trainings said that the experience of riding in the earthquake simulation vehicle was extremely beneficial, and that it made them realize the importance of earthquake countermeasures. The earthquake simulation vehicles, which can easily make small turns, are now visiting regions all over Peru so that the local people can experience the shaking of an earthquake. Earthquake simulation vehicles allow trainers to experience simulated earthquakes up to magnitude 7 for two minutes at a time and can be customized according to local needs. Starting with the introduction of these vehicles, it is hoped that disaster-prevention awareness will further grow among the people of Peru, and that preparations for large-scale disasters will be undertaken in every household (MOFA 2019, 64).

8.4.3 Case 8.7: *Kizuna*: Disaster Risk Reduction Training Program for Latin America and the Caribbean

Chile and Japan have a long history of cooperation in disaster risk reduction with successful results, including the improvement of a tsunami warning system, the development of a rapid building inspection sheet, and the update of a manual on bridge seismic criteria.

On Sept. 16, 2015 at 7:54 p.m., central Chile was struck by an earthquake with an 8.3 magnitude. Immediately when the earthquake struck, there was a tsunami warning issued that urged residents to evacuate to higher ground. Consequently, considering the size of the earthquake, human casualties were kept to a relative minimum. This was due to a "prompt response by the Chilean government, related organizations and local residents," and was highly praised by the United Nations. "One of the factors that made such a response possible was the disaster risk reduction support JICA has been providing for a number of years. Chile's experience demonstrated the effectiveness of JICA's diverse range of support for developing infrastructure and human resources, including revisions to earthquake resistance standards for buildings, improvements to the tsunami warning system and the implementation of evacuation training programs" (JICA 2015, 1). In Chile, an Integrated System of Prediction and Warning of Tsunami (SIPAT) was developed and started to operate from 2016.

Kizuna, Disaster Risk Reduction Training Program for Latin America and the Caribbean was launched in March 2015 at the Third UN World Conference on Disaster Risk Reduction (DRR) in Sendai, Japan. Its overall goal is to strengthen the capacity of human resources and networks in DRR and improve measures for DRR in countries of the region. It aims to train more than 4000 professionals in the region. *Kizuna* is implemented by the Agency of International Cooperation and Development (AGCID), JICA, and the National Emergency Office (ONEMI) of the Ministry of the Interior and Public Security of Chile (the Technical Manager of *Kizuna*).

8.5 Concluding Remarks

The determinants of learning discussed in Chap. 2 can also be observed in the cases of disaster risk management. Easy entry points and low-cost solutions were identified in the BOSAI Projects. First, risk literacy was enhanced, with the focus on making the residents fully understand the risks of their own community and take actions on their own. From the perspective of continuous improvement or Kaizen in the context of BOSAI to cope with ever-changing risks, capacity development (CD) aims to let the community members prepare risk maps and disaster management plans—as well as improve them—on their own. CD processes at the levels of both the community and local government strengthened their capacity to respond effectively to various disasters and to take various concrete actions. From these experiences, we could confirm that resilience is indeed about learning to live with risks. Effective learning by communities and their members has taken place in the BOSAI Projects. BOSAI at the community level is effective only when the process is inclusive, whereby all members contribute to and receive benefits from the BOSAI activities.

Learning by doing, mutual learning, and co-creation of innovative solutions were also a feature of BOSAI and related activities. As discussed, major achievements at the community level include the development of organizations, risk maps, evacuation routes, early warning systems, and emergency response plans. Greater levels of involvement and commitment of voluntary labor were also observed. We can recognize clearly that, through this process, there was mutual learning among stakeholders and successful co-creation of innovative solutions. In Taishin Projects, low-cost earthquake-resistant housing technology—established through cutting-edge laboratory experiments—was provided for free as a public good. This technology opened up the possibility of a new type of inclusive business for low-income people with the participation of other stakeholders in El Salvador, such as NGOs. The technology has now been shared with some other Central American countries. In BOSAI, TAISHIN, and GENSAI Projects, capacity development to strengthen resilience through organizational learning and institution-building took place. As such, learning, including learning to learn, effectively contributed to innovative and inclusive development, enhancing resilience in El Salvador and other Central American countries that belong to the Center of Coordination for the Prevention of Natural Disasters in Central America (CEPREDENAC).

Furthermore, the use of emergency warning broadcast systems, earthquake simulation vehicles, and so on, based on cutting edge technologies, can enhance the awareness and resilience of people to cope with disaster risks. The recruitment and training of professionals for institutions in charge of DRR through programs such as *Kizuna* may further enhance the resilience of society to natural disasters. We can confirm that learning, resilient infrastructure, and institutions, are among other things, crucial in the process of transforming societies into more resilient ones.

Notes

1. According to JICA (2017), these priority areas and strategies are based on lessons learnt through JICA's activities in the disaster risk reduction sector, which originally were gained through long efforts and experience within Japan. 'The Sendai Disaster Risk Reduction Framework' explicitly demonstrates the global recognition of these important strategies (3).
2. This and the following three paragraphs related to the three types of gaps draw on the presentation made by Shinya Ejima, Director General of the Global Environment Department of JICA, on the occasion of an ASEAN meeting in April 2012. Errors and omissions are those of the author.
3. According to JICA (2017), BOSAI, Disaster Risk Reduction, is a series of efforts to reduce economic and physical loss in case of disasters to ensure the overall development process is not disturbed.
4. For Chagas disease, see Case 8.2.
5. Frog Caravan (Caravana de Rana) is an innovative training system to learn about natural disaster prevention developed by Plus Arts (+Arts), a Japanese NPO, in 2005. In Japan the frog is considered a friendly symbol promoting good feelings and Frog Caravans tour schools, involving local officials, teachers and schoolchildren, and introduce for example games for teaching children how to extinguish fires or rescue people trapped under rubble in the wake of an earthquake.
6. This part of the experiences of Santa Tecla is based on the author's interview with its Mayor, Mr. Oscar Ortiz on August 28, 2012.
7. See Chap. 6 for a full discussion of land readjustment.
8. The assassin bug transmitting Chagas disease resides in the walls and floors of adobe houses. For further information on Chagas disease, see https://www.jica.go.jp/usa/english/office/others/newsletter/2014/1405_06_05.html.
9. This and the following three paragraphs are based on Yanase (2018). Errors and omissions are of the author.
10. This case mainly draws from MOFA (2019).
11. This case draws from MOFA (2019).

References

Aldrich DP, Oum S, Sawada Y (2015) Resilience and recovery in Asian disasters: community ties, market mechanisms, and governance. Springer, Tokyo

BOSAI Terminal Evaluation Team (2012) Terminal evaluation report for the project on capacity development for disaster risk management in Central America “BOSAI”. JICA, Tokyo

de Souza FF (2018) Concepts on land adjustment. In: de Souza FF, Ochi T, Hosono A (eds) Land readjustment: solving urban problems through innovative approach. JICA Research Institute, Tokyo, pp 15–33

Ejima S (2012) Mega-disaster and economic development in Asia: from the perspective of safer and sustainable development. In: Presentation at ASEAN meeting, 26 Apr 2012

Global Facility for Disaster Reduction and Recovery (GFDRR) and World Bank (2015) Investing in urban resilience: protecting and promoting development in a changing world. World Bank, Washington, DC

Hosono A (2012) Climate change, disaster risk management and south-south/triangular cooperation. In: JICA (ed) Scaling up south-south and triangular cooperation. JICA, Tokyo, pp 15–41

Ishiwatari M (2016) Saigai ni taisuru kyoujinsei ga shitsu no takai seichou ni kouken suruniha: Bosai enjyo ga chokumen suru kadai [How resilience against disasters contributes to quality growth? Challenges of cooperation for disaster risk reduction]. JICA Research Institute, Tokyo

JICA (2015) KIZUNA project launched—impressive results from early evacuations, improved seismic resistance in buildings. JICA News, 2 Nov 2015. https://www.jica.go.jp/english/news/field/2015/151102_01.html

JICA (2016) Bosai: disaster risk reduction. JICA, Tokyo

JICA (2017) Disaster resilient society for all: integrating disaster risk reduction challenges with sustainable development. JICA, Tokyo

JICA y Ministerio de Obras Públicas (MOP) (2019) Gestión de Riesgo de Desastres en la Infraestructura Pública de El Salvador: Construyendo Infraestructura Resilientes. JICA and MOP, Tokyo and San Salvador

Ministry of Foreign Affairs (MOFA) (2019) White paper on development cooperation. MOFA, Tokyo

Saito S (2012) The Taishin triangular initiative in Central America: co-creating quake-resistant construction methods for popular low-cost housing. In: JICA (ed) Scaling up south-south and triangular cooperation. JICA, Tokyo, pp 173–190

Sawada Y (2007) The impact of natural and manmade disasters on household welfare. Agric Econ 37(s1):59–73

United Nations Office for Disaster Risk Reduction (UNISDR) (2009) 2009 UNISDR terminology on disaster risk reduction. UNISDR, Geneva

United Nations Office for Disaster Risk Reduction (UNISDR) (2015) Sendai framework for disaster risk reduction 2015–2030. UNISDR, Geneva

World Bank (2005) Natural disaster hotspots: a global risk analysis. World Bank, Washington, DC

Yanase N (2018) Land readjustment and post-disaster reconstruction in Japan. In: de Souza FF, Ochi T, Hosono A (eds) Land readjustment: solving urban problems through innovative approach. JICA Research Institute, Tokyo, pp 63–78