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Current Trends in Eco-Friendly Reconstruction after the Great East Japan Earthquake

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***Abstract*—**On March 11, 2011, the East coast of Japan was hit by one of the strongest earthquakes in history, followed by a devastating tsunami. Although most lifelines, infrastructure, and public facilities have been restored gradually, recovery efforts in terms of disposal of disaster waste and revival of primary industry are lagging. This study presents a summary of the damage inflicted by the earthquake and the current status of reconstruction in the disaster area. Moreover, we discuss the current trends and future perspectives on recently implemented eco-friendly reconstruction projects and focus on the pro-environmental behavior of disaster victims which is emerging as a result of the energy shortage after the earthquake. Finally, we offer ideas for initiatives for the next stage of the reconstruction policies.

***Keywords*—**Agriculture, Disaster wastes, Pro-environmental behavior, Reconstruction policies.

I. Introduction

ON March 11, 2011, the Great East Japan Earthquake occurred off the coast of Sanriku, Japan. The magnitude of the earthquake was 9.0, which is the highest ever measured in Japan. The quake caused series of violent tremors in various areas in East Japan, including the Tokyo Metropolitan Area. Moreover, a massive tsunami with a height exceeding 10 m hit the coastal area in the Tohoku region in the hours following the earthquake, causing catastrophic damage to human life and infrastructure. The tsunami also hit the Fukushima Daiichi Nuclear Power Plant and destroyed reactor cooling systems and emergency power systems. As a result, several of the reactors suffered major damage that led to full or partial core melt. This serious nuclear accident certainly obstructs the efforts to recover from the crisis.

A great challenge facing Japan is to eliminate the effects of the so-called triple disaster (strong earthquake, devastating tsunami, and nuclear accident). Therefore, Japan should aim to build a sustainable society in the reconstruction process rather than simply restoring the infrastructure. At this stage, it is necessary to raise awareness among citizens of pro-environmental behavior that would allow for eco-friendly reconstruction in the long term.

This study is intended as a survey of the trends in eco-friendly reconstruction projects and the emerging pro-environmental behavior in victims of the Great East Japan Earthquake. From an environmental viewpoint, we discuss the current status and future perspectives on the reconstruction policies.

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II. Method

A. Survey of the Current Status of Disaster Areas

The Tohoku region is located in northeast Japan (Fig. 1). The disaster area (mainly Iwate, Miyagi, and Fukushima prefectures) suffered extensive damage caused by the tsunami in addition to the violent tremors. Based on data from government surveys and press releases, we reviewed the disaster damage and the progress in terms of reconstruction policies.

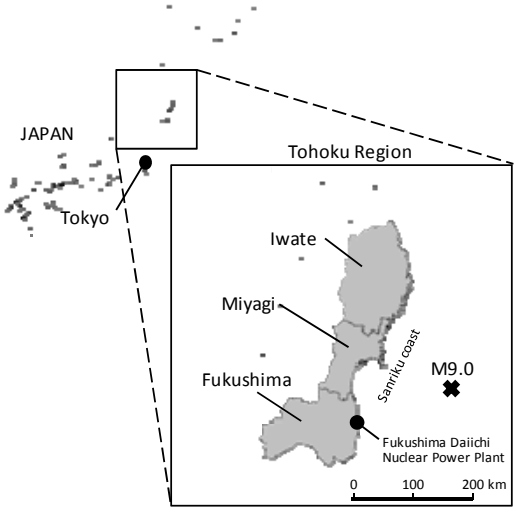


Fig. 1 Area affected by the Great East Japan Earthquake

B. Survey of Current Trends in Eco-Friendly Reconstruction Projects

After the earthquake, eco-friendly reconstruction projects started to take off in the disaster areas. In this study, we focus on projects regarding disaster waste recycling and decontamination activities of salinized agricultural lands. By conducting interviews with experts involved in these activities, we reviewed the current status and future perspectives on eco-friendly reconstruction projects.

C. Questionnaire Survey on the Pro-Environmental Behavior of Disaster Victims

Naturally, the energy shortage caused by the nuclear accident has hindered the efforts for rapid recovery. However, from another viewpoint, this accident may have prompted many Japanese to reconsider their own behavior with respect to

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environmental issues, such as energy saving and the 3R strategy (Reduce, Reuse, Recycle). In this study, a questionnaire survey regarding environmental and energy issues was administered to with approximately 150 individuals who were evacuated from the nuclear accident site. Anonymous survey sheets were collected by mail.

III. Result and Discussion

A. Overview of Damage Inflicted by Disasters

Table I presents an overview of the damage sustained in the Great East Japan Earthquake. In terms of human damage, the disaster claimed the lives a total of 15,867 people, with another 2,906 reported missing. The great majority of human damage was in Iwate, Miyagi, and Fukushima prefectures, with drowning accounting for 90.6% of all deaths [1], revealing the immensity of damage caused by the tsunami. Regarding building damage, more than 1 million units were completely or partially destroyed. The great majority of damaged buildings were also within Iwate, Miyagi, and Fukushima prefectures, as in the case of human damage. Most of the cases of complete collapse are believed to have been caused by the tsunami.

TABLE I
Overview of Disaster Damage

Prefecture	Iwate	Miyagi	Fukushima	Total
Human damage				
Dead	4,671	9,524	1,606	15,867
Missing	1,211	1,479	212	2,906
Injured	201	4,136	182	6,109
Building damage (units)				
complete collapse	20,191	85,310	20,757	130,436
Partial collapse	4,690	151,486	69,938	263,950
Partial damage	8,271	223,181	158,815	720,249

Data as of July 18, 2012, taken from publicly available materials released by the National Police Agency of Japan [1].

The tsunami inflicted heavy damage on harbor facilities and marine vessels on the Sanriku coast. An estimated more than 300 fishing ports and 20,000 vessels were destroyed, and most coastal agricultural lands were submerged as a result of the tsunami, with deep repercussions for agriculture. Thus, the tsunami destroyed most resources of primary industries in the disaster areas.

The nuclear accident at the Fukushima Daiichi Nuclear Power Plant only worsened the situation. According to an official government report, 1.5×10^{16} Bq of ^{137}Cs and 1.1×10^{19} Bq of ^{133}Xe were emitted into the environment [2]. Although the nuclear reactors have been cooled to a stable regime, the emission of radionuclides has not ceased. As a result, Fukushima Prefecture has been confronted by a large-scale exodus. According to the demographic statistics for Fukushima Prefecture, the population before the disaster was 2,024,401. After the earthquake, approximately 40,000 people moved to other areas, leading to a reduction in the nominal gross prefectural production by 1.4% [3].

According to estimates by the Japanese government, losses due to the earthquake may run from 6 trillion to 25 trillion yen [4]. However, indirect damage such as the decrease in consumption and the decline in the value of fixed assets has not been considered in this preliminary estimate. Thus, the actual economic damage might be even worse.

B. Progress in Reconstruction Policies

In the post-quake period, rescue teams and volunteers, including international support, played a major role in lifesaving operations and the restoration of lifelines. With the advancement of restoration, improvements in governance must be implemented to design efficient strategies for reconstruction. The Reconstruction Agency was established in February 2012 as a contact center for reconstruction-related requests from local governments in the disaster areas. Flexible policy management and centralized management of cross-sectional issues are expected from the agency.

Owing to the gradual progress in reconstruction policies, the number of evacuees has been reduced to about 340,000 as of May 31, 2012, from about 470,000 in the post-earthquake period [5]. Approximately 95% of evacuees have moved into temporary housing. To date, most lifelines (e.g., electricity, water and gas supply services), infrastructure (e.g., road traffic networks, railway services, communication networks), and public facilities (e.g., school, hospital, waste disposal plants) have been restored, except in the evacuation zone surrounding the nuclear power plant. Moreover, several local governments are expending considerable efforts toward the construction of new local communities. Aid from the Japanese government now focuses on industrial revival and employment promotion in the disaster areas.

On the other hand, the disposal of disaster waste and the revival of primary industry are found to have lagged behind in the reconstruction efforts. More than 22.5 Mt of waste was generated in the disaster, and only 2.8 Mt (corresponding to c.a. 12% of the total) of that has been disposed of to date. Furthermore, there has been a long delay in the restoration of agricultural lands and harbor facilities that were destroyed by the tsunami (agricultural lands: about 39%; farm woodlands: about 40%; marine product processing facilities: about 50%) [5]. In this context, complete reconstruction is still a long way away.

C. Outcomes, Problems, and Future Perspectives on Eco-Friendly Reconstruction Projects

From the viewpoint of restoration of the infrastructure and public services, reconstruction policies appear to be progressing well. As mentioned above, however, the delay in the disposal of the enormous quantities of disaster waste has slowed down the reconstruction process. As a means of solving this problem, projects for recycling disaster waste into reusable materials are drawing attention as an eco-friendly reconstruction route. Such projects are based on technology for recycling woody waste to soil alternatives. Recycled soil promotes the growth of plants, where it has been reported that the weight of plant mass in recycled soil increases 1.5-fold above ground and 2.8-fold in the root systems as compared with common decomposed granite soil [6]. This technology is

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expected to be applicable to woody waste separated from disaster waste.

In addition, broken concrete and asphalt could be used as aggregates in the construction of roads and dikes. By covering the dikes with recycled soil, a wide variety of plants can be expected to grow thickly on the structure surface. This not only promotes biodiversity, but also serves a disaster prevention function as a result of increased water retention capacity. Currently, the Japanese government is eager to find ways for the complete disposal of disaster waste. The enforcement of a framework that requires a certain quantity of disaster waste to be used in the construction of roads or dikes can result in the launching of new environmental industries in the disaster areas along with the mitigation of waste issues.

In addition to the problem of disaster waste, the revival of primary industries is also a great challenge. In particular, coastal agricultural lands suffered extensive damage when they were submerged in sea water, and projects for decontamination of salinized agricultural lands have been commenced as a means of solving this problem. Soil salinity can be decreased effectively by letting water flow through fallow fields [7], which was originally employed as a farming method for activating microorganisms in the soil. Enhanced biodiversity increases agricultural productivity. However, the restoration of agricultural land does not necessarily entail the revival of agriculture. Agriculture in Japan faces a number of challenges, such as a sharp shortage of capable workers resulting from the aging of the workforce. Since coastal agricultural lands play the important role of preventing the submergence of inland urban areas, agriculture is in need of immediate revival.

In this way, eco-friendly reconstruction projects receive considerable attention in the disaster areas. To accelerate the adoption of these trends, it is necessary to raise awareness of environmental concerns.

D. Current Status of Pro-Environmental Behavior of Disaster Victims

To build sustainable communities in the disaster areas, it is important to initiate interest in pro-environmental behavior. A questionnaire-based survey regarding environmental and energy issues was conducted with the aim to understand the current status of the behavior of disaster victims after the earthquake. Individuals who were evacuated from the area of the nuclear accident were surveyed, with 91 (males: 42; females: 49) returning valid responses (recovery: 62%). Fig. 2 shows the main results of the survey, and details regarding the 5 questions are provided below.

Q1) How concerned are you about environmental issues?

More than 90% of respondents indicated that they were “Very concerned” or “Moderately concerned” about environmental issues (Fig. 2(b)). In terms of age brackets, about 60% of respondents who provided the answer “Very concerned” were in their 50s or older, with the ratio for the same response decreasing to about 40% for respondents in their 40s and about 20% for respondents in their 30s or younger.

Q2) How concerned are you about energy issues?

More than 90% of respondents indicated that they were “Very concerned” or “Moderately concerned” about energy issues (Fig. 2(c)). In terms of age brackets, the answer “Very concerned” was provided by 75% to 95% of respondents in their 50s or younger. This suggests that the problem of energy shortage caused by the disaster had a stronger impact on younger generations.

Q3) How concerned are you with pro-environmental behavior?

More than 90% of respondents indicated that they were “Very concerned” or “Moderately concerned” with pro-environmental behavior (Fig. 2(d)). In terms of age brackets, the ratio of the answer “very concerned” was significantly higher in respondents in their 30s or younger (c.a. 80%). Growing concern about energy issues has possibly led the emergence of a pro-environmental behavior in younger generations.

Q4) Please indicate the pro-environmental behaviors you have adopted (multiple choice).

Fig. 2(e) illustrates the details of behaviors adopted by respondents whose answer to Q3 was “Very concerned” or “Moderately concerned”. The answer “Saving electricity” ranked at the top of the list, followed by “Separating waste for recycling” and “Refusing to use plastic shopping bags”. In terms of age brackets (not shown), for respondents in their 30s or younger, the respective ratios of the answers “Saving electricity” and “Using public transportation instead of a car” are relatively high as compared with other generations. Consequently, we can conclude that the disaster has initiated changes in the pro-environmental behavior particularly in younger generations.

Q5) Do you agree with the introduction of environmental taxes?

Approximately 50% of respondents indicated that they “Strongly agree” or “Agree”, and 30% indicated that they “Disagree” or “Strongly disagree” with the introduction of environmental taxes (Fig. 2(f)). The remaining 20% of the respondents answered "Not applicable" (N/A). In terms of age brackets, for respondents in their 60s or older, the ratio of positive answers accounted for over half of the total. In contrast, for respondents in their 50s or younger, negative answers tended to be more common than positive ones, showing that opinions on the introduction of environmental taxes are divided. In this regard, there is an incomplete understanding of the framework of environmental taxes.

Therefore, it appears that growing concern about environmental and energy issues has led the emergence of pro-environmental behavior, particularly in the younger generations. However, there is still strong opposition to the introduction of environmental taxes, whose purpose is to introduce a social cost to the price of goods and services. In this regard, the improvement of economic incentives is expected to promote the emergence of pro-environmental behavior, and there is a clear need to promote a public understanding of the framework of environmental taxes.

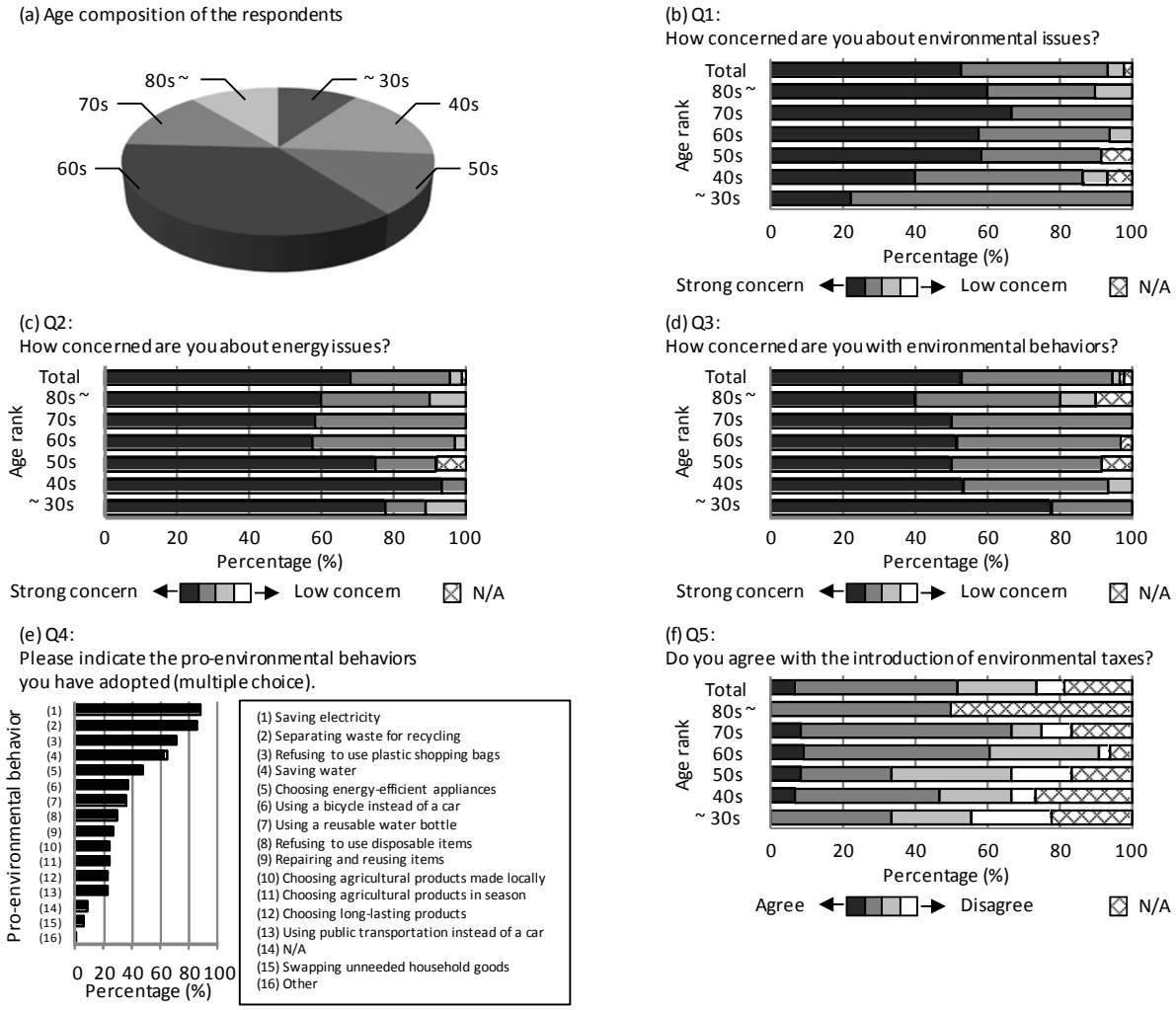


Fig. 2 Trends in of the concern for about environmental issues and the pro-environmental behavior of the disaster victims

IV. Conclusion

Recovery from the damage sustained in the Great East Japan Earthquake is a major challenge for Japan in the 21st century. It is also the first step in the process of moving toward a sustainable society. In the disaster areas, the implementation of eco-friendly reconstruction projects has just commenced, and growing concern about environmental issues is expected to accelerate the progress of such projects. Consequently, eco-friendly projects are likely to lead to the establishment of new environmental industries, thus boosting local economies in the reconstruction period. We believe that this is the ideal scenario for the next stage of the implementation of reconstruction policies.

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