KNOWLEDGE NOTE 2-8

CLUSTER 2: Nonstructural Measures

Green Belts and Coastal Risk Management

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Green Belts and Coastal Risk Management

For more than four centuries Japan has been developing forested green belts to mitigate coastal hazards such as sandstorms, salty winds, high tides, and tsunamis. Although Japan's green belts were severely damaged by the March 11 tsunami, they did reduce the impact of waves, and protected houses by capturing floating debris. Local governments are planning to reconstruct the green belts as a countermeasure against tsunamis. While local communities have traditionally taken charge of maintaining green belts, their role has been weakened because of changes in society brought about by economic development and urbanization.

FINDINGS

Japan is surrounded by the sea; its coastline measures approximately 34,000 kilometers, with 1,640 square kilometers (km2) of a forested green belt distributed along its sandy coast. For more than four centuries Japan has been developing this green belt. Composed mainly of Japanese black pine (box 1), it serves various functions. It reduces the impact of coastal hazards such as blown sand, salty winds, high tides, and tsunamis. Japan's Forest Law stipulates that disaster risk management (DRM) forests should be planted in coastal areas to prevent damages from wind, airborne sand, and tsunamis. Another benefit of the greenbelt is that it is a scenic landscape called *hakusa-seisyou* in Japanese, which means "beautiful coast with pine trees and sandy beach." Its role as a tourist attraction has become increasingly important as Japanese society has become more affluent.

In the Sendai Plain, pine forests, 200 to 400 meters wide along Sendai Bay, have for the past four centuries mitigated disasters and provided beautiful scenery consisting of green forests, white sands, and blue ocean. Masamune Date, a distinguished feudal lord, started to plant Japanese black pines along the Teizan Channel on the Sendai Plain in 1600. The people who lived on the dunes along the coast had suffered from sandstorms and tidal disasters that damaged their agricultural products, and the pine forests protected their fields. Masamune allowed the people to sell wood from branches that were trimmed or had fallen to cover the expense of maintaining the green belt.

BOX 1: **Takatamatsubara and the hope of recovery**

In the disaster-affected areas of Tohoku, there were several famous coastal forests. Takatamatsubara of Rikuzen Takata City was a 21-hectare coastal forest, 2 kilometers long and 200 meters wide, consisting of some 70,000 pine trees. In the 17th century, a wealthy merchant started planting pine trees in the barren coastal areas to protect agricultural lands from heavy winds and salt water. Another merchant began planting in the 18th century. The local communities developed and maintained the forests for some 350 years, conducting annual festivals to commemorate the two merchants. These coastal forests had also been a tourist attraction where a million or so people came to bathe or enjoy nature every year. After the GEJE disaster only a single pine tree remained—a meager symbol of hope of recovery.
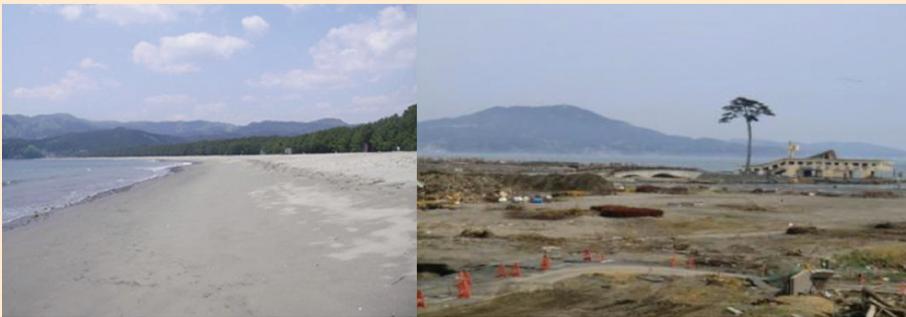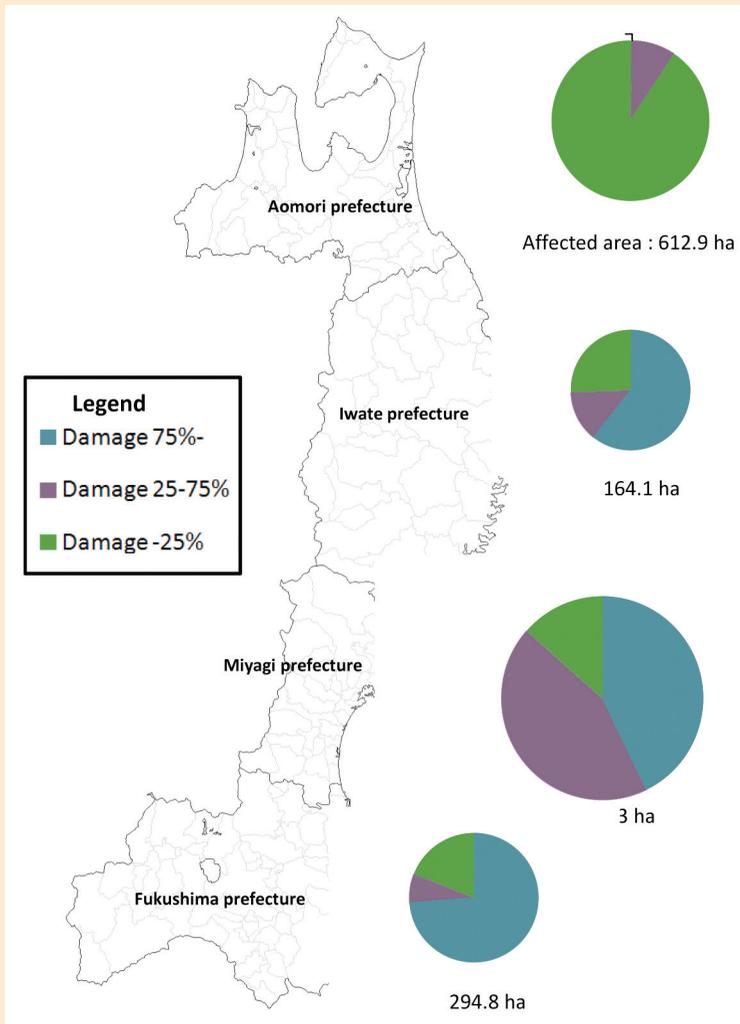

Source: Ministry of Environment.

In the late 19th century, the Japanese government designated Reserved Forests, maintaining their DRM function. In 1933 the green belt mitigated damages from the Syowa Sanriku tsunami. In 1935 the government started an afforestation program to mitigate tsunami damage; and again promoted afforestation following the Chilean earthquake tsunami in 1960.

The green belt became less important after the rapid economic growth of the 1970s, as other more effective DRM measures were developed, and electricity and gas replaced wood as energy sources for people. The community's role in managing the green belt diminished, and governments took over its maintenance.

DAMAGE TO THE GREEN BELT

In the Great East Japan Earthquake (GEJE) of 2011, 3,660 hectares (ha) of the green belt were damaged by the tsunami, at a cost of ¥55 billion. In the four affected prefectures, 2,825 ha of the green belt were flooded; and 1,069 ha of the green belt were damaged more than 75 percent (figure 1). The green belt of the Miyagi Prefecture was severely damaged—trees were uprooted or bent, or their trunks were broken.

FIGURE 1: **GEJE tsunami damage to the green belt in four prefectures**

Aomori prefecture

Affected area : 612.9 ha

Legend
- Damage 75%-
- Damage 25-75%
- Damage -25%

Iwate prefecture

164.1 ha

Miyagi prefecture

3 ha

Fukushima prefecture

294.8 ha

Source: Forest Agency 2011.

The green belt reduced the impact of the tsunami, delayed its arrival time, and protected houses by capturing drifting debris. Several ways in which the green belt reduced damages have been reported. In Hachinohe City, Aomori Prefecture, a forest caught 20 ships washed inland by a 6-meter tsunami, thereby protecting the houses located behind the trees (figure

FIGURE 2: **The forest captures a floating ship**

Source: Forest Agency 2011.

2). Although these houses were inundated by over 3 meters of water, they were not washed away. In past tsunami disasters, the following benefits have been confirmed:

- The energy and speeds of the tsunamis decreased.

- Floating wreckage was blocked.

- People washed away by the tsunami were able to save their lives by clinging to trees.

- The trees helped preserve sand dunes, which in turn mitigated the force of the tsunami.

Natori City was hit by a tsunami of 8.5 meters. Almost all of the green belt was flooded and 106 ha (more than 80 percent) was damaged. Figure 3 shows the condition of the green belt in Natori City before and after the tsunami. The extent of the damage differed by location depending on the geographic conditions on the ocean side. In the northern part, which had sand embankments from port construction, the green belt was preserved; in the middle portion, which had no barrier, the green belt was washed away or knocked down; and in the southern part, the presence of a tidal embankment preserved the green belt.

Local governments are planning to restore DRM coastal forests as one of their structural countermeasures, along with dikes and mounds. The Forest Agency suggests that the forests should be at least 50 meters wide, and preferably 200 meters, for effective DRM in

FIGURE 3: **Condition of the green belt before and after the tsunami in Natori City**

Before Tsunami

After Tsunami

500m

survived pine trees because of sand embankment

died pine trees because of no barrier

survived pine trees because of tide embankment

Source: Forest Agency 2011.

coastal areas. DRM effects can be increased with building mounds; and debris, which is a serious obstacle to rehabilitation, can be used for building mounds.

The Miyagi prefectural government recommended the following actions to help the recovery of DRM forests:

- Coordinating with other rehabilitation works, such as coastal dikes and debris management.

- Selecting tree species that conform to local conditions and support biodiversity.

- Collaborating with nonprofit organizations, volunteers, and the private sector.

MAINTENANCE

Community action is essential to maintaining the coastal green belt. Local communities had historically developed and maintained the green belt to protect their houses and agricultural

FIGURE 4: **Changing approaches to managing the green belt**
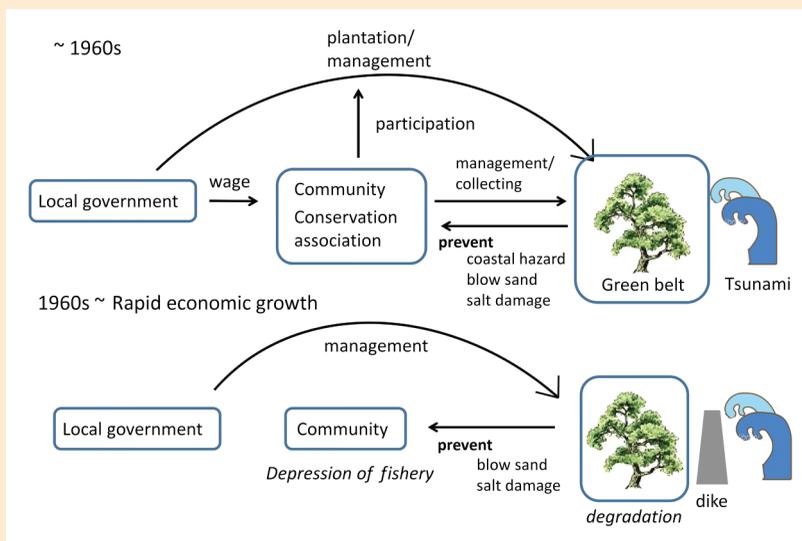
Source: Forest Agency 2011.

lands from coastal hazards. Proper maintenance is required to preserve the forest's DRM function: trees should be planted with moderate density, and frequent thinning is required otherwise the trees will not develop to their full size.

Since the late 1960s, the community's role in managing the green belt diminished as Japan experienced rapid economic growth; as previously noted, governments took over their management (figure 4). Growth led to the development of infrastructure such as dikes and new energy installations, while the fishing and agriculture industries lagged behind. Dikes replaced the green belt in coastal hazard prevention; and communities started using coal instead of pine trees as a fuel source. Community-based organizations (CBOs) that had managed the green belt broke up as communities lost interest and the government was unable to manage and maintain such vast forested areas. Moreover, damage caused by the pine weevil became a serious problem from the 1990s.

LESSONS

- Green belts can be effective against small tsunamis, sea winds, or sands, but not against a huge tsunami like that of March 11. Combining green belts with dikes and embankments can strengthen their effectiveness (KN 2-3-1).

- Green belts reduce tsunami damage by reducing wave energy, delaying water arrival time, and protecting houses by capturing floating debris.

- Green belts also provide other important benefits recognized by communities, such as protection from coastal storms, salt damage, and sand and provide spaces for recreation and wildlife. Forests may also provide psychological safety and augment well-being.

- Green belts require several decades to develop properly. Japan has had over four centuries of experience in their development.

- Local communities can play important roles in green belt maintenance. Maintenance mechanisms should be modified as society changes. In Japan the government expanded its roles as the economy grew.

RECOMMENDATIONS FOR DEVELOPING COUNTRIES

Forest projects can be effective countermeasures against tsunamis, floods, and other water-related disasters. Forested green belts can decrease disaster risks by reducing the force of natural hazards. During the Indian Ocean tsunami in 2004, mangroves and other coastal green belts mitigated potential damages due to the disaster.

Understand the DRM function of the green belt. Public awareness of the DRM function of the green belt should be raised. Also, information should be shared with decision makers to promote green belts.

Utilize the forest as a means of livelihood. In Japan forests have been used along rivers to mitigate floods, and farmers use bamboo from the green belts to produce handicrafts that provide them with additional income. Farmers can also earn from fuel woods and nontimber products, such as fruits, flowers, and medicinal plants.

Foster participatory maintenance. Restoring the green belts includes two major activities: cultivation and sustainable management which should involve several stakeholders. Plantations can be jointly implemented by the government and civil society, including the community. Community participation in cultivation leads to a sense of ownership. Communities can continue using the green belt as a space to learn skills and as a way of maintaining relationships with external organizations.

Support community. Local governments and civil society organizations play an important role in increasing awareness and engaging the local community. DRM education in schools will also raise awareness and encourage participation.

KEY REFERENCES

Haraguchi, T., and A. Iwamatsu. 2011. *Detailed Maps of the Impacts of the 2011 Japan Tsunami* (1): 167. Koko Shoin Publishers Ltd.

Investigative Committee on Revitalization of Coastal Forests Associated with Great East Japan Earthquake. 2012. *Revitalization of Coastal Forest (Kongoniokeru kaigan bousair-inno saiseinitsuite).* Forestry Agency.

Miyagi Prefecture. 2012. *Report on the Survey on Appropriate Species for Plantation of Coastal Forest (Kaigan bousairin ni tekishita shokusaijyu shu ni kansuru chousa houkokusho)*.

Natori City. 2011. *Report on Tsunami Damage in Natori City*.

Noguchi, Y., R. Shaw, and Y. Takeuchi. 2012. "Green Belt and Its Implication for Coastal Risk Reduction: The Case of Yuriage." In *East Japan Earthquake and Tsunami: Evacuation, Communication, Education and Volunteerism*, ed. R. Shaw and Y. Takeuchi. Singapore: Research Publishing.

Yuriage-kyoudoshikenkyukai. 1977. *Records of the Culture and Geography of Yuriage*, 460.