Several Measures to Enhance the Forest Function of Preventing Natural Disasters

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~ Outline of the Presentation~

1. Features of the National Land of Japan

2. Former Japanese Forest and the History of Forest Rehabilitation

3. Several Measures to Enhance the Forest Function of Preventing Natural Disasters

4. International Cooperation of Japan
1. Features of the National Land of Japan
A Disaster-prone Country

- **Steep topology**

- **Massive precipitation**

- **Two to three typhoons strike annually**

**Averge: 807 mm/year**

Source: Based on data from Japanese Resource 2014 (MLIT)

Source: Website of the Japan Meteorological Agency

Source: Website of MLIT KANTO
A Disaster-prone Country (cont.)

- Number of active volcanos

<table>
<thead>
<tr>
<th>World</th>
<th>1,551</th>
</tr>
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<tbody>
<tr>
<td>Japan</td>
<td>110 (7.1%)</td>
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- Number of earthquakes (magnitude of 6.0 or greater)

<table>
<thead>
<tr>
<th>World</th>
<th>1,758</th>
</tr>
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<tbody>
<tr>
<td>Japan</td>
<td>326 (18.5%)</td>
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</table>

Source: White Paper on Disaster Management in FY2014
A Disaster-prone Country (cont.)

- Number of Deaths and Missing Persons in Disasters

Source: Based on the data from White Paper on Disaster Management in FY2012 and FY2014

※1: Figure 6,437 stands for the number from the Great Hanshin-Awaji Earthquake in 1994.
※2: Figure 18,559 stands for the number from the Great East Japan Earthquake in 2011.
Demand for wood increased due to modernization works after Meiji Restoration in 1868.
Great amounts of wood were cut down as important domestic resource during and following World War II.

Source: National Land Afforestation Promotion Organization, The Commemorative Photographs of 60th Tree-Planting Ceremony
Influence of forest devastation brought about repeated water and mountain disasters such as Typhoon Catherine, which caused unprecedented flood in 1947.

Forest improvement projects and erosion control projects have been promoted since mid 1950s.

Tamano City, OKAYAMA in 1950s
Forest was devastated by excessive cutting.

Tamano City, OKAYAMA Current
Rich forest was recovered.

Under the work (Stair Slope Work) (around 1953)
Restoration of over harvested forests (cont.)

■ Composition of forest age class of planted forest in Japan

![Graph showing forest age distribution](chart.png)

- In 1966
- As of March 2012

During and following World War II, devastated coastal forests caused huge damage toward houses and farms. Rehabilitation projects for coastal forests had been intensively promoted since early 1950s.
Occurrence of mountain disasters shows decreasing trend although there are several singular values.
Forests that are particularly requested to demonstrate public welfare such as land conservation and headwaters conservation are designated as “Protection Forests” and are appropriately protected by means of logging restrictions and other measures.

### Breakdown of national land area and forest area

- **Protection Forest**: 120.9 (thousand km²)
- **Residential land**: 19.0
- **Agricultural land**: 45.5
- **Others**: 52.8
- **Others**: 127.4

### Types of Protection Forest

- **Protection Forest for headwaters conservation**
- **Protection Forest for landslide prevention**
- **Protection Forest for tide damage prevention**

Source: Basted on data in Japan Statistical Yearbook 2015 (Ministry of Internal Affairs and Communications) and Forest and Forestry Statistics Catalogue 2014 (Forestry Agency)
Mechanism of forest functions for protection of sediment disasters and soil protection

Comparison of average annual erosion depths

Forest land prevents sheet erosion and sediment discharge

- Forest land resistant to sheet erosion
- Bare land susceptible to sheet erosion

Note: These values are the average of those measured values of erosion that are for slopes of 13° or over.

Comparison with the condition above ground

Mechanism of forest functions for protection of sediment disasters and soil protection

Fallen or decomposed leaves absorb the impact of raindrops.
Membranes formed from crushed soil particles

Rainwater

Undergrowth

Dilapidated land
Arable land
Forest

Infiltration

23.6 mm/year
1.1 mm/year
0.2 mm/year

(c.f.) Comparison of average annual erosion depths
Mechanism of forest functions for protection of sediment disasters and soil protection (cont.)

Function to prevent shallow landslide

Roots grip shallow soil and prevent shallow landslide

Effects of lateral roots and vertical roots

Lateral roots tying down soil

Slip surface (layer)

Vertical roots showing their piling effect that fixates slip surfaces

Schematic illustration of the uplift resistance of roots (revised from Kitahara, 2006)

(c.f.) Deep-seated landslide

A slope collapses from a depth beyond the reach of forest roots is called Deep-seated landslide.

Thinning thickens roots, which activates root swelling.

Forest not thinned on a timely basis

Appropriately thinned forest
Improvement of forest preventive functions by thinning

- Thick floor vegetation prevents sheet erosion.
- Growth of trees and roots prevents shallow landslide.
Hillside Work

Facilities intended to stabilize the mountain slopes, including landslide protection work and vegetation work are laid out appropriately to match the characteristics of each failure so as to promote sure restoration of forests.

Stream Work

Construction of erosion control dams and other facilities prevents erosion of banks and beds of mountain streams and stabilizes the foot slopes thereby to ensure the growth basis of forests.

Restoration and regeneration of forest by hillside work (Shinoyama City, HYOGO)

collapse (1996)  Immediately after the work (1998)  Around 10 years after the work

Stream Work

Combination of Hillside Work and Stream Work

Sediments deposited and stabilized

↑ Figure with the mountain stream seen from the side
In order to improve preventive functions of forests, it is important to design erosion control projects and forest improvement activities as a comprehensive program.
■ Restoration and regeneration of collapse by heavy rain (Syodoshima town, KAGAWA)

Collapse  Under the work  About 20 years after the work
■ Restoration and regeneration of collapse by earthquake （Otaki village, NAGANO）

Collapse  
Under the work  
About 30 years after the work
- Restoration and regeneration of devastated forest caused by eruption with aerial sowing
  (Shimabara City, NAGASAKI)

Before the eruption

Collapse

About 7 years after the work

Under the work
Effects of forest against debris flow

- Forest trees captured rocks and driftwood from debris flow at the heavy rain disaster in HIROSHIMA, August 2014.
Effects of Costal Protection Forests against Tsunami caused by the Great East Japan Earthquake

- Costal Protection Forests attenuated the tsunami energy and captured wreckage.

**Effects of Costal Protection Forests against tsunami damage**

- **Hachinohe City, AOMORI**
  - Boats and steel pipes were caught.
  - Inundated houses were preserved.

- **Watari Town, MIYAGI**
  - Boats were caught.

- **Iwaki City, FUKUSHIMA**
  - Cars were caught.

- Coastal Protection Forests attenuated the tsunami energy and captured wreckage.
Effects of Costal Protection Forest against Tsunami caused by the Great East Japan Earthquake (cont.)

- However, 140km of Costal Protection Forests from AOMORI to CHIBA were damaged by tsunami.

## Damages of Costal Protection Forests

- **Whole forest was disappeared**
  - Rikuzentakata City, IWATE

- **Embankment and forest were damaged**
  - Misawa City, AOMORI

- **Forest was partially damaged**

- **Embankment was destroyed**

- **Damaged roots**
  - Sendai City, MIYAGI

- **Damaged stems**
  - Noda Village, IWATE

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*Effects of Costal Protection Forests on Tsunami, Great East Japan Earthquake.*

[Image of damaged forest with labels indicating locations and types of damages.]
The objective of restoration project is not only improvement of sand and wind prevention but also tsunami damage mitigation. Different measures are chosen for each damaged coast taking into consideration of geographical, ecological and social features.

### Schematic illustration of restoration of coastal protection forest (desired future vision)

- **Seaside**
  - **Seaside forest zone dense with low trees**
    - Attenuation of tsunami energy
  - **Artificial embankment**
    - Mitigation of wind or blown sand
    - Attenuation of tsunami energy

- **Landside**
  - **Landside forest zones with large diameter trees**
    - Capture of driftwood or wreckage with large-diameter trees
    - Attenuation of tsunami energy
    - Retention of the windbreaking function with trees that survived after tsunami damage
  - **Growth base embankment**
    - Sound growth of roots
    - Prevention of tree uprooting
  - **Recycled materials originated from disaster-related wastes**
    - whose safety as embankment materials is proven are used.
  - **Tide wall**
    - Constructed when necessary to protect forest zones in the hinterland
  - **Service road**

- **Tree species high enough to demonstrate sufficient windbreaking effects**
- **Tree species sufficiently resistant to blown sand, salty wind damage or cold wind damage**
- **Wide forest zone**
  - A height of 2 to 3 m from the groundwater level is retained.
  - (Examples)
    - Overstory tree: Japanese black pine
    - Understory trees: Pittosporum tobira, Japanese emperor oak, Rhaphiolepis indica var. umbellata
  - (Examples)
    - Overstory trees: Japanese black pine, Machilus thunbergii, Quercus serrata
    - Understory trees: Pittosporum tobira, Japanese emperor oak, Rhaphiolepis indica var. umbellata
4. International Cooperation of Japan
Adaptation of erosion control technology toward oversea projects

- JICA: Project on forest restoration after the earthquake in Sichuan Province
  (from 2010 to 2015)
  - Forests in Sichuan Province, China were severely damaged by the earthquake in 2008.
  - Japan introduced the erosion control technology and assisted to restore the forest through JICA Technical Cooperation.
  - As a result of this project the government of China decided to provide “erosion control forestry” in the Forest Act. Japan could contribute to improve disaster management system of China.