

* Post-Fire Restoration Principles for the Korean Forest

: Practice from Eastern Coastal Forest Fire, 2000

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- Restoration Practices
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- Restoration Cases

Overview: Background

Restoration Practices on degraded land after Korean War (1960-70s)



Hillside work



Planting work by president family

Overview: Background

• denuded land in 1984



• Immediately after Restoration



• 5 months after restoration



• Landscape in 2005



* Overview: Background



1996



2006

- Forest fire in 1996 at the Eastern Mountainous Region made nationwide public concern on the danger & threat of fire
- In 3 days Damages are: 3,834ha forest, 92 houses & 135 barns, 718 cattle, 21,052 fruit trees, 17,545 farming machines, and 142 people lost home(Gov. compensation + 8.7m\$)
- Reported: need 40~100 years to recover naturally, lost major income from pine mushroom etc.
- Cause and Problem: early stage control failure by explosion risks, strong wind, other fires and no air support etc.
- Dense Forest & more outdoor activities caused more forest fires

* Overview: **Background**

- 2000, Forest fire at the Eastern Coastal Region triggered national level argument with an issue How formulating a plan to restore
- Post-fire restoration programme is highly required to consider the ecological, scenic, and economical value
- As fire destroy forests in large areas & more frequently, standard protocols and principles were needed
- The goals were to develop standard post-fire restoration protocol according to the scale of damage and site condition, and to restore healthy and sound forest.

2000, Forest fire at the Eastern Coastal Region



* Overview: Definitions

A. Damage Level Classification

(1) Disaster Level

An area proclaimed as national level disaster, significantly threatening local and national level of economic and societal activities

(2) General Level

Where forest fire damage causes limited disturbance & issues to the local society
Small burned areas

B. Restoration types

(1) Urgent Recovery

To complete the erosion control works prior to the following rainy season (summer).
The key purpose of this process is to prevent secondary damage (e.g., landslide, soil erosion, and sediment runoff) in burned area.

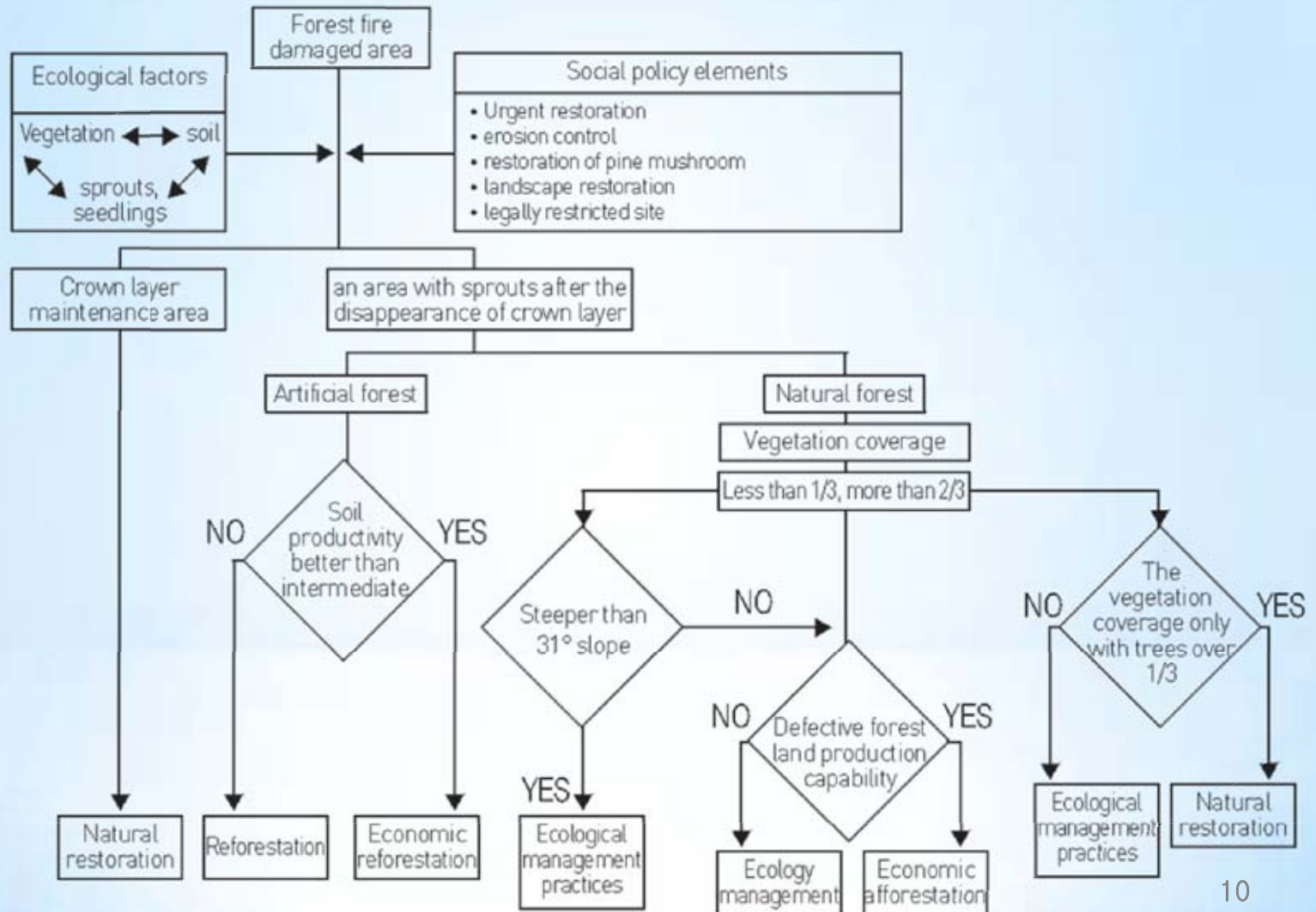
(2) Long-term Restoration

To restore the six major functions of forest ASAP, which are lost due to forest fire, through planned restoration process.

* Overview: Restoration Process

1. **Identifying Urgent Recovery Sites:** Immediately identify the area in danger with soil erosion and landslide, to conduct emergency restoration.
2. **Classifying Damage Level:** According to the size and severity of fire, classify areas into **Disaster or general level**, and then assess the magnitude of damage.
 - A: **Disaster Level Area:** Under the supervision of Korea Forest Service, conduct a comprehensive and integrated investigation as a group including NGOs and academic communities
 - B: **General Level Area:** Investigation carried out by local government (city, county) or Regional Forest Service
3. **Setting up a Long-term Restoration Plan** and execute an annual restoration plan based on the magnitude of damage
4. **Monitoring the sites** after Restoration
 - A: the site evaluated as successful restoration, post-restoration management is followed
 - B: poorly restored areas need additional supplement restoration works

* Forest Restoration decision making flow chart for the sites of 2000 fire



* Formulating Restoration Plan: **Damage Assessment**

For Areas Requiring Urgent Recovery

- Where: Burned areas vulnerable to secondary damage such as landslide and soil erosion could caused by following heavy rain.
- Who: Regional authority and regional Forest Service. Erosion control experts could be included
- When: Immediately after fire termination.
- What: Including slope angle, parent rock, hydrologic conditions, and vegetation coverage.
- How: Identify area vulnerable to landslide using topographic map. Field survey to confirm the devised plan is applicable.



* Example of
Urgent Recovery

* Formulating Restoration Plan: **Damage Assessment**

For Long-term Restoration Plan

(1) Inventory to investigate : An investigation team chooses items independently according to the regional needs and characteristics

(2) Examples of investigation items

- Scale of damage: size of burned area, level of fire severity, financial loss
- Vegetation: Remaining vegetation, types of secondary vegetation, vegetation coverage, sprouting and regeneration
- Terrestrial ecosystem: Insect, mammals, birds, amphibians, reptiles, rare animals and plants.
- Aquatic ecosystem: Fishery, aquatic organisms, etc.
- Soil: Site environment, soil productivity, woodland preservation, micro-organisms (e.g., pine mushrooms)
- Socio-economic characteristics: Societal evaluation, economic evaluation, etc.



* Formulating Restoration Plan: **Additional Guideline**

(1) Link with forest's six functions

To restore :

- Timber production forest (1)
 - plant the species adequate for timber production plantation
 - Water conservation forest(2)
 - plant species mixed with deep & shallow-rooted hardwood species
 - Disaster prevention forest(3)
 - follow the erosion control process
 - Natural environment conservation forest(4)
 - do natural restoration: no application apply , let the nature take it
 - Ecosystem conservation forests(5) & recreational forests(6)
 - apply all application : natural restoration, scenic forestation, erosion control and ecological based works, etc.
- * Consider the increase of income for forest owners and residents

* Formulating Restoration Plan: **Additional Guideline**

(2) Methods to handle burned stand

- Retain burned stands at natural restoration target areas
 - Conduct patch clearcutting or strip cutting on timber production forests
 - Execute strip cutting with 20m cut with 10m residue following topographic contour. If not possible, the strip direction could be vertical instead of horizontal.
 - Conduct patch clearcutting with considering scenic features.
 - Clearcut for the pine mushroom production site, scenic area, fire-resistant forest, and area requiring urgent erosion control.
 - The size of clearcut patch should be less than 5ha in order to minimize the soil disturbance
 - Trees should be cut around 60cm from the ground, so it can act as a barrier (a log strip terracing work). Allocate branches and other woody materials along the trunks following topographic contour to prevent ash and soil erosion.
 - When pile woody materials, the heap should be 10m long and 1m wide. The distance between piles should be approximately 5m
 - Building barriers(a log strip terrace) made of burned trees were the most effective way to prevent soil erosion (Figure 3). However, piling up the burned trees horizontally may be an affordable option (Figure 4).
- ※ Minimize the use of heavy equipments during burned tree treatment to prevent soil disturbance (e.g., soil compaction).

* Practice for Urgent Restoration

A. Practice Principles

- Comply with the 『Erosion control technical manual (2002)』 published by Korea Forest Service
- When: If forest fire occurs during spring, restoration should be completed before the East Asian monsoon starts in the end of June.

B. Areas be Considered

- Areas vulnerable to landslide and sediment runoff, which is described in 『Law on the erosion control』 and 『Forest basic law』, respectively.
- Areas where the residents are likely to be damaged, such as houses, farmland, roads, etc.
- Mountainside stream stabilized areas

C. Applications

- Slope stabilizing methods and erosion control structures.
- As for the types, standard, and the cost of erosion control structures, refer 『Erosion control technical manual (2002)』, published by Korea Forest Service (e.g. hillside stone masonry works, piling up green bags and sod-pitching works)

* Practice for Urgent Restoration



Hillside stone masonry works	• Mountain slope or the foot of a mountain that is easy to access and steeper than 45° with extensive sedimentation
Piling up green bags	• Area that is difficult to access and so barren that the sod is hardly attached to the soil
Sod-pitching works	• Slope with relatively fertile soil and with a slope of 45° or less
Seed spraying	• Area where there is a need to establish vegetation quickly when hillside stone masonry works or piling up the green bags are done

* Practice for Long-term Restoration

✓ Principles

- Long-term restoration should be related in the six functions of forest.
- 6 functions is not fit for All forests - such as pine mushroom production and fruit tree planting, regional socio-natural characteristics or residents' opinion should be reflected in the restoration plan.
- Urgent restoration sites also be included

✓ Two Restoration Types

A. Natural restoration :

for Wilderness, Forest Area to Reserve Natural Environment

B. Human restoration :

with 6 functions to improve economic, ecological and environmental values as well as natural landscape

❖for Natural Restoration

✓ Areas

- Designated areas permanently by Law and Act as the Natural Environment Conservation Forest in the 6 functions
 - Forests under the control of the 『Act on the preservation of the *Baekdudaegan*』 (The Baekdudaegan is a 1,400km mountain system that forms the backbone of the Korean Peninsula).
 - Forests within the natural park according to the 『Natural park law』 .
- Areas with potential resources for natural restoration or regeneration, such as un-burned crown layer with seeds or roots for shoot
- Areas where foresters require the maintenance to preserve the natural environment.

❖for Natural Restoration

✓ Guidelines

- Regenerate with natural sprouts or seeds.
- Preserve all potential forest resources that are worthy of
- *Pinus densiflora* could die in three years after forest fire even though it survives in the year of the damage. Thus, remaining trees should be monitored for at least three years.
- Manage sprout by tending if necessary, once the soil is stabilized.
- Install necessary structures, Even after restoration is completed, remnant part of dead trees or rocks could move & damage on the sites during heavy rain. Thus, if necessary, install structures such as ring net on the applicable area.
- Avoid major changes in forest structures and maintain the stability, once the restoration process is completed,

* Practice for **Long-term Restoration**

❖for Natural Restoration



Human Restoration

✓ **Types & Process**

A. Vegetation Restoration for the forest of

- 1) Timber production
- 2) Water supply
- 3) Natural disaster management
- 4) Recreational, living environment conservation
- 5) Others

B. Restoration at steep area

- 1) Reforestation for erosion control
- 2) Facilities for erosion control

C. Fire break

- 1) Build up and manage fire break
- 2) Follow-up maintenance for fire break sites

❖ **Vegetation R. of Human Restoration**

1) Timber Production :

✓ **Target Areas**

- by Act:
 - Economic Forests Complex described in 『Act on the Formation and Management of Forest Resources』
 - Timber Production Forests described in 『Act on Forestry and Mountain Village Promotion』 .
- Areas with less than 30° slope and with outstanding soil fertility, for timber production.
- Areas where foresters require to manage for timber production.

❖ Vegetation R. of Human Restoration

1) Forest for Timber Production

✓ Guideline

- Major planting trees should be economic species.
- Supplementary species is for the ecological stability or additional timber product.
- Within a site, consider the functions and physiology of the species based on the micro-topography such as valley, toe of a mountain, mountainside, mountaintop, etc.
- Burned trees: Strip or patch clear cutting (less than 5ha)

Forest zone	Major species	Supplementary species
Temperate Northern	<i>Pinus koraiensis</i> , <i>Larix kaempferi</i> , <i>Pinus densiflora</i> , <i>Betula platyphylla</i> , <i>Quercus</i> spp.,	<i>Abies holophylla</i> , <i>Fraxinus rhynchophylla</i> , <i>Betula costata</i>
Temperate Middle	<i>Pinus koraiensis</i> , <i>Larix kaempferi</i> , <i>Pinus densiflora</i> , <i>Betula platyphylla</i> , <i>Quercus</i> spp., <i>Liriodendron tulipifera</i>	<i>Pinus rigitaeda</i> , <i>Juglans mandshurica</i> , <i>Pinus strobus</i> , <i>Fraxinus rhynchophylla</i> , <i>Betula costata</i> , <i>Zelkova serrata</i>
Temperate Southern	<i>Larix kaempferi</i> , <i>Pinus densiflora</i> , <i>Quercus</i> spp., <i>Liriodendron tulipifera</i>	<i>Pinus thunbergii</i> , <i>Pinus rigitaeda</i> , <i>Fraxinus rhynchophylla</i> , <i>Betula schmidtii</i> , <i>Juglans mandshurica</i>
Warm temperate	<i>Pinus thunbergii</i> , <i>Chamaecyparis obtusa</i> , <i>Liriodendron tulipifera</i>	<i>Pinus taeda</i> , <i>Cryptomeria japonica</i> , <i>Quercus myrsinifolia</i> , <i>Machilus thunbergii</i>

❖ **Vegetation R. of Human Restoration**

2) For Water Supply

✓ **Target Areas**

- by Act & Law
 - Watershed protection forest areas described in the 『Act on the FMFR』
 - Forested area in a water conservation zone according to the 『Waterworks law』
- Areas where foresters require to manage for water conservation

✓ **Guidelines**

- Areas with potential resources for natural restoration or regeneration - such as enough sprouts, take natural restoration process to ensure soil stability. Plant seedlings, if necessary.
- To create multi-layered root structures, deep-rooted tree species such as oaks should be the major species, and shallow-rooted and intermediate-rooted species should be planted as well.
- Burned trees can be recycled for erosion control or replace them to avoid sliding, fire and any kind of disaster.

❖ Vegetation R. of Human Restoration

3) For Natural Disaster Management

✓ Target Areas

- by Act & Law
 - Erosion control site (including landslide rehabilitation site) described in 『Erosion control law』
 - Soil erosion protection forest described in 『Basic forest law』
- Area vulnerable to landslide and sediment runoff.
- Areas where foresters require to manage against natural disaster

✓ Guidelines

- Plant species for higher nitrogen fixation ability such as *Alnus japonica*, *Robinia pseudo-acacia*, *Lespedeza bicolor*, and fast growing species as well
- To create multi-layered root structures, deep-rooted tree species such as Oaks and Pines should be the major species, and shallow-rooted and intermediate-rooted species should be planted as well.
- Plant hardwood species on a site with deep soils while softwood species on a site with shallow soils.

Use of Debris





❖ **Vegetation R. of Human Restoration**

4) Others



Reforestation for restoring pine mushroom

- Consider for the area produced pine mushroom and the area nearby.
- Form *Pinus densiflora* forests to restore pine mushroom production forests
- Plant locally-grown bare root seedlings or containerized seedlings of *Pinus densiflora*.
- Clearcutting all the burned trees recommended



Orchard reforestation

- In case of owner demand
- Sites with slope of 20° or less with fertile soil
- For the sites to raise income with *Castanea crenata*, *Prunus mume*, etc.

❖ **Vegetation R. of Human Restoration**

4) Others

➤ Practices for the Ecological fundamental

- For areas requires supplementary planting due to the lack of sprouts and poor soil productivity.
- To help natural restoration process, minimum supplementary can be considered on the site of poor vegetation recovery after burn.
- Plant seedlings of drought-resistant species such as *Quercus variabilis*, *Pinus densiflora*, etc., or reforest by direct seeding.
- Retain as many burned tree particles as possible

D) For Scenic beauty

- Area near national roads and around a city.
- Area near cultural landscape resources and tourist sites.
- Plant scenic valuable species including *Prunus sargentii*, *Acer triflorum*, *Sorbus commixta*, *Cornus controversa*, *Euonymus alatus*, *Styrax obassia*, *Styrax japonica*, *Aesculus turbinata*, *Sophoru japonica*, etc.

❖ Restoration at Steep Area of Human Restoration

➤ Restoration for erosion control

- * Similar to the forest for the preventing all types of mountain disasters such as landslide, sediment runoff, etc.
- * On the Sites vulnerable to landslide and areas that are difficult to recover naturally.
- * Remove all burned trees.
- * Planting tree species: *Pinus densiflora*, *Alnus hirsuta*, *Quercus variabilis*, *Lespedeza* spp.
- * Recovering vegetation is more important than economic viability.
- *

➤ Facilities for erosion control

- * Valley sites where could block runoff and driftwood comes down from upper burned area.
- * Remove the burned trees that impede work.
- * Do natural or Human restoration according to the classification of functions



❖ Fire break of Human Restoration

➤ Build up and manage fire break

Where to :

- Forests near the main facilities · roads · railways · forest roads · towns located at the area where the handling of the timber products is possible.
- ※ Main facilities : power plants · military bases · temples · heritage sites, etc.
- Large coniferous forests that is vulnerable to fire spread by flying fire debris.
- Disaster level fire damaged area where vulnerable to forest fire recurrence
- Forests nearby mountain ridge
- Limited to the area where the road can be installed without other damages to carry out remnants

❖ Fire break of Human Restoration

➤ Build up and manage fire break

✓ Overall Guidelines

- Form the buffer zone (bare ground, no tree green zone, etc.) with width of 20~50m near the protecting facilities
- In case of conifer stands, maintaining 100 stems per ha is recommended.
- if necessary, clearcut the conifer stands and re-plant broadleaves trees .
- Heavily thinning with width of 30m is required on the existing forest where the outside of buffer zone,

➤ Follow-up maintenance on the fire break

- Understory broadleaves species
 - Do 『Coppice regeneration』 to mix with the existing conifers.
 - Manage the sites approximately 3 years according to the sprouting state.
 - Human reforestation is a viable option if necessary
- Removal of understory shrub and herb
 - Remove shrubs· herbs to avoid the risk of fire spread and crown fire
 - Manage the sites for 2 to 5 years according to the status

* Follow-up Management

✓ Monitoring

- Monitor the sites once between 3 to 5 years after work is completed.
- Monitor twice : in the middle term and at the end of whole period
- Monitoring Team Composition is as same as the assessment team
- Feedback is need such as additional supplement

✓ Weed and Vine removal

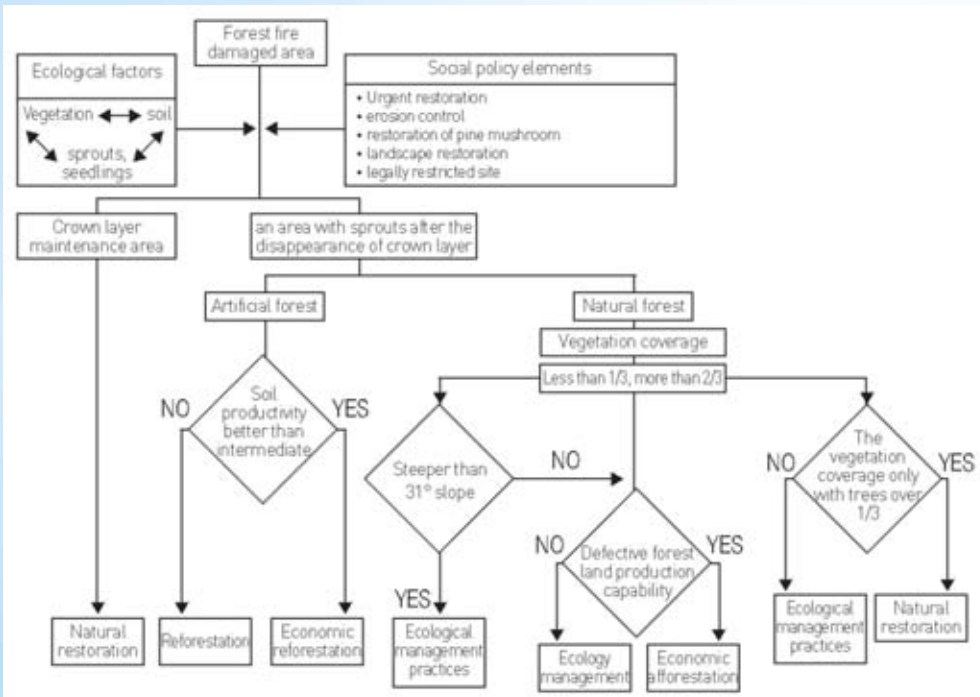
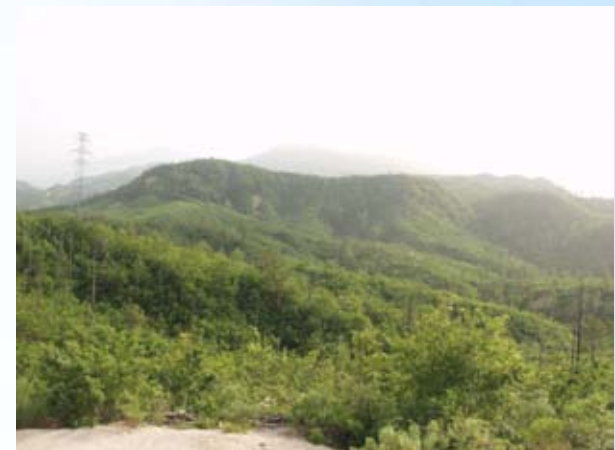
- Apply weed removal, one or two times per year for three to five years after seedling establishment, but execute flexibly according to the field conditions.
- Remove vine using physical method.
- Use chemical method only when inevitable.

✓ Fertilizer Application

- Apply slowly available fertilizer between May and June when seedlings take root.

* Restoration cases

- Eastern Costal Forest Fire in 2000 April 7~15
 - 5 areas, Killed 2, 23,794ha, 850 people lost home,



* Restoration cases

- CheongYang & Yeosan Forest
Fire in 2002 April, 500ha, 200 lost
home



* Restoration cases

- YangYang Eastern Costal Forest
Fire in 2005 April, 973ha,
lost 22 national treasure, 418 lost home



