A Proposal of New Indicator for Soil Erosion – How implement Forest Floor Cover Management? –

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Outline

I. Soil erosion of forested area in Japan

II. Why is "forest floor cover" so important?

III. Monitoring soil erosion in NFI

IV. Forest Floor Cover Management for SFM

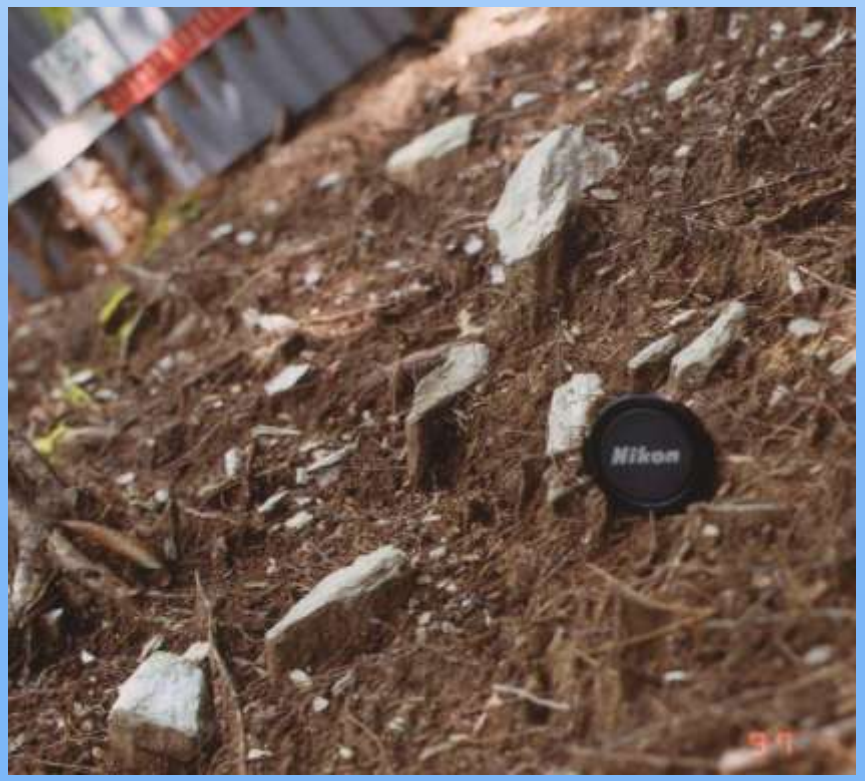
I. Soil erosion of forested area in Japan

Raindrop splash, quick progress

Consequence of floor cover removal treatment

Splash

Pedestal



Recent threats of soil erosion (1) forest type, deer

Cedar

Cypress

Effect of tree species

- Vulnerable Cypress vs Cedar
  (*Chamaecyparis obtusa vs Cryptomeria japonica*)
- Low protective effect of scaly needles of Cypress

(Photo by H. Furusawa)

Browsing damage by deer: deer excluded (left) vs not excluded (right)

Recent threats of soil erosion (2) associated with harvesting

(Photo by S. Sasaki)

- Improper managed un-afforested stands
- Mainly in south-western part of Japan
- Severe erosion along skid trails

Strong soil disturbance by forestry machines

Recent threats of soil erosion (3) natural disturbance

Severe rill erosion on volcanic ash deposition (Miyake island)

Historical forest soil degradation by human impacts (1) Ashio copper mine

Bald mountains, forests were completely destroyed by sulfurous acid gas from Ashio copper mine

Forests recovered in 2000s with high reforestation costs.

Have soils fully developed, or not?

1960s (begun in 19th century) → 2000s

(Photos by Forest Agency)

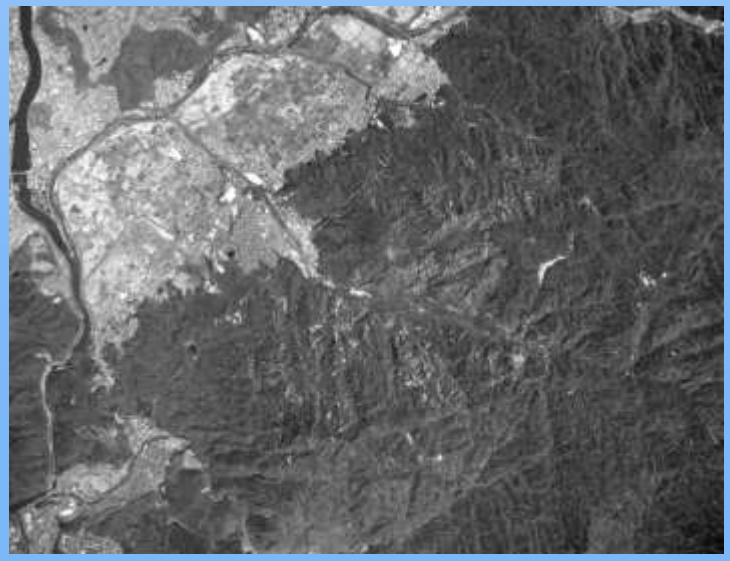
Historical forest soil degradation by human impacts (2) Tanakami mountains near Kyoto

Bald mountains, forests severely damaged by continuous utilization of litters and roots from Edo era or earlier, in Tanakami mountains

Forests recovered in 2000s by much efforts.

Have functions of soils and other services recovered or not?

1948 (began in 17-18th century) → 2000s



(Photos by GSI, Japan)

Summary

'Canopy' or 'Floor'

- Loss of floor cover accelerates soil erosion quickly

- Erosion worsens:
  Splash -> Surface flow -> rills and gullies

- Excessive human activities will devastate forests and soils

II. Why is "forest floor cover" so important?

Why … cause foundational functions

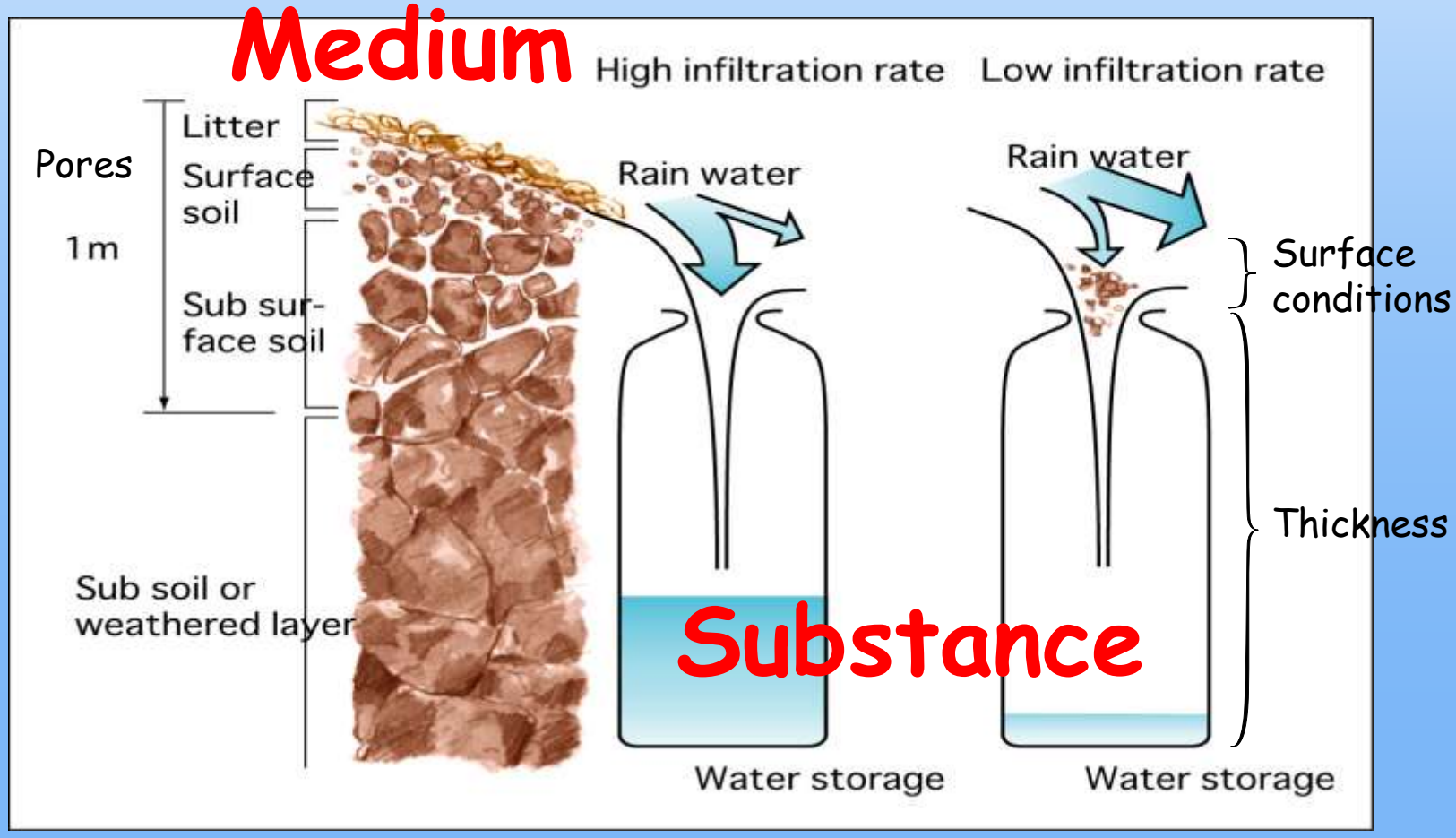
Because,

- forest soil supports ecosystem services

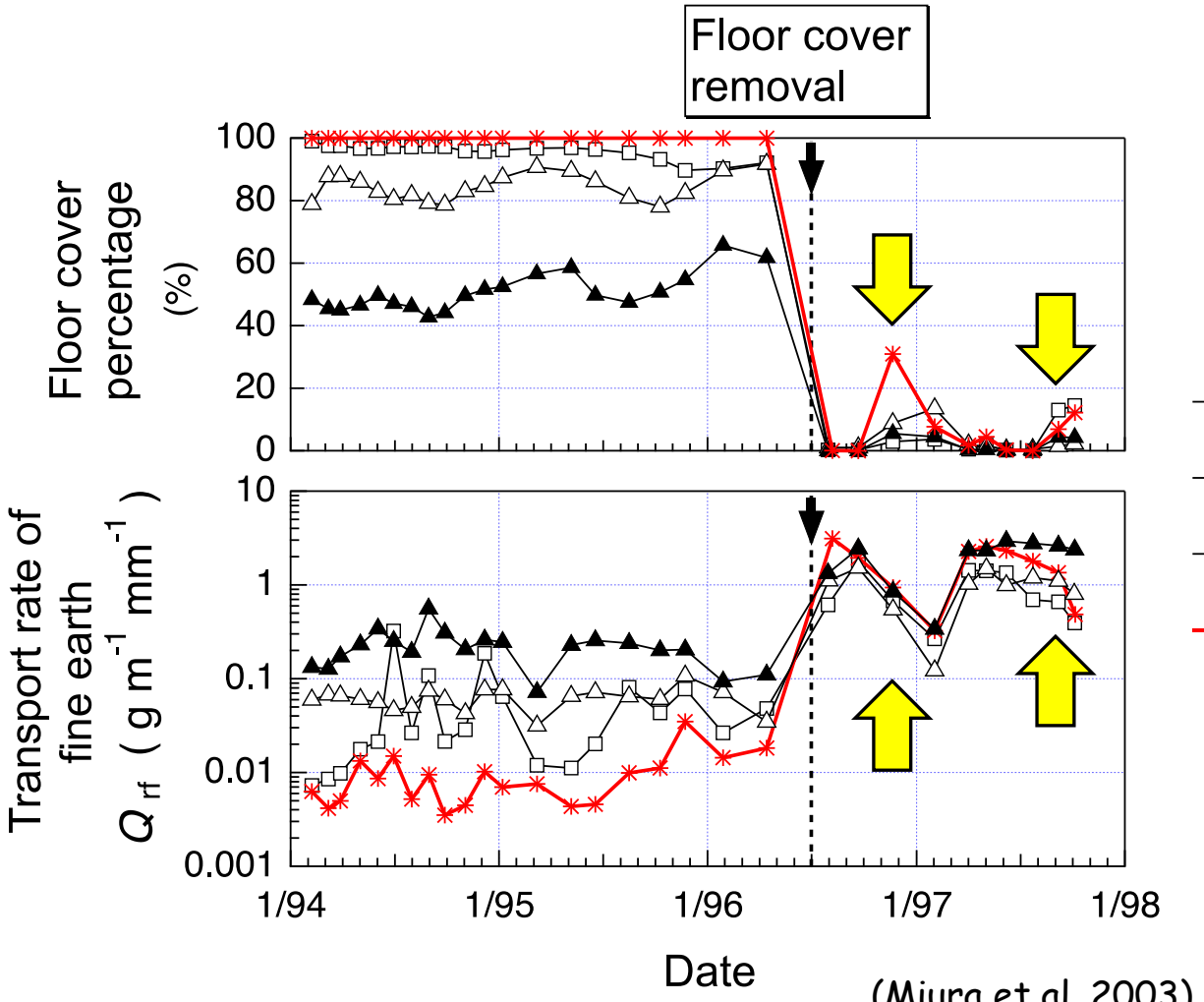
and,

- **soil** is a primary **regulating factor** (**RF**) of most ecosystem services
- **floor cover** protects **soils** from **erosion**

RF for water holding capacity, regulation, filtering



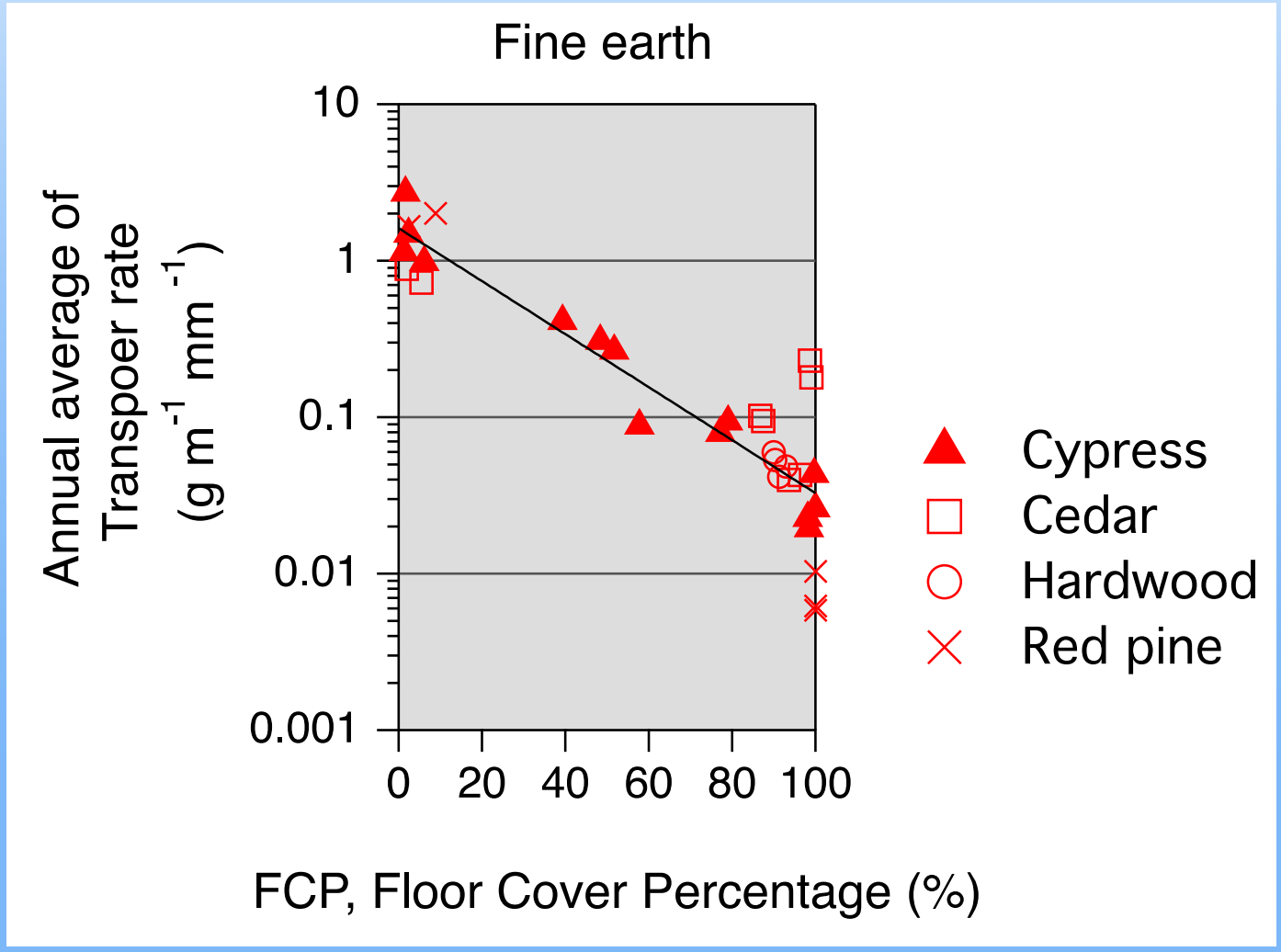
Susceptive erosion response to change of floor coverage



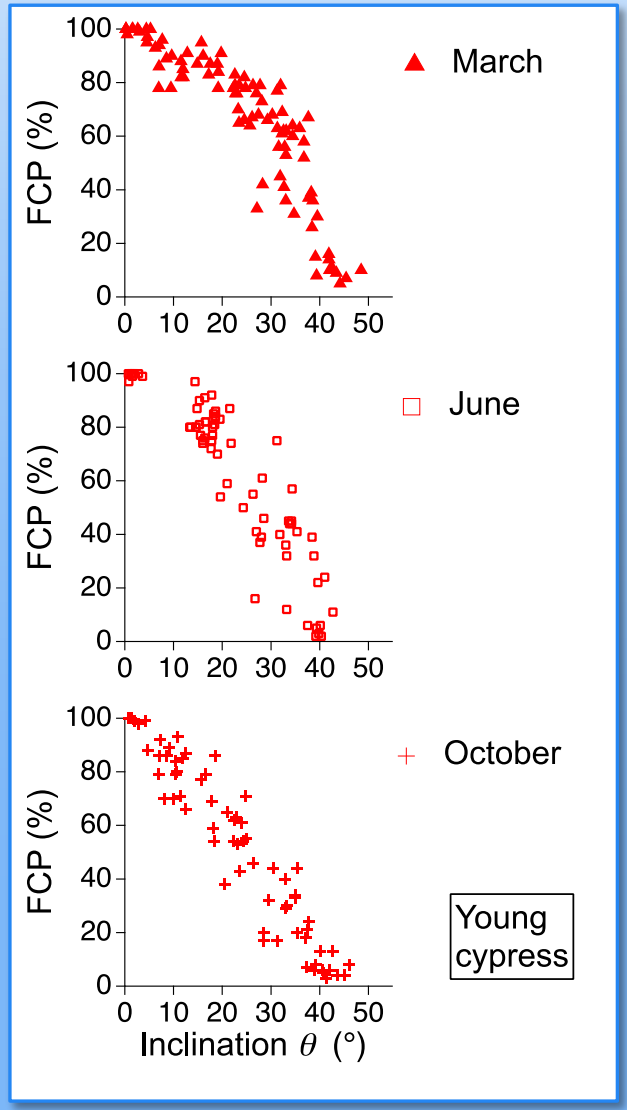
(Miura et al. 2003)

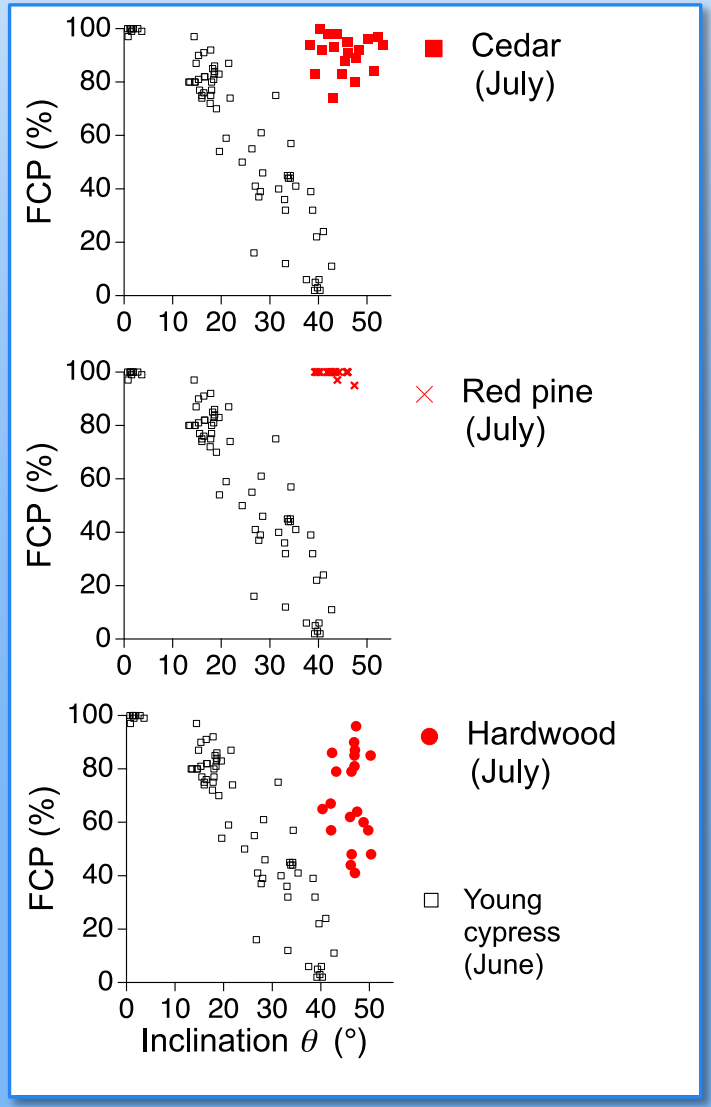
Young cypress C
Young cypress B
Young cedar F
Middle red pine I

What factor? – floor cover percentage

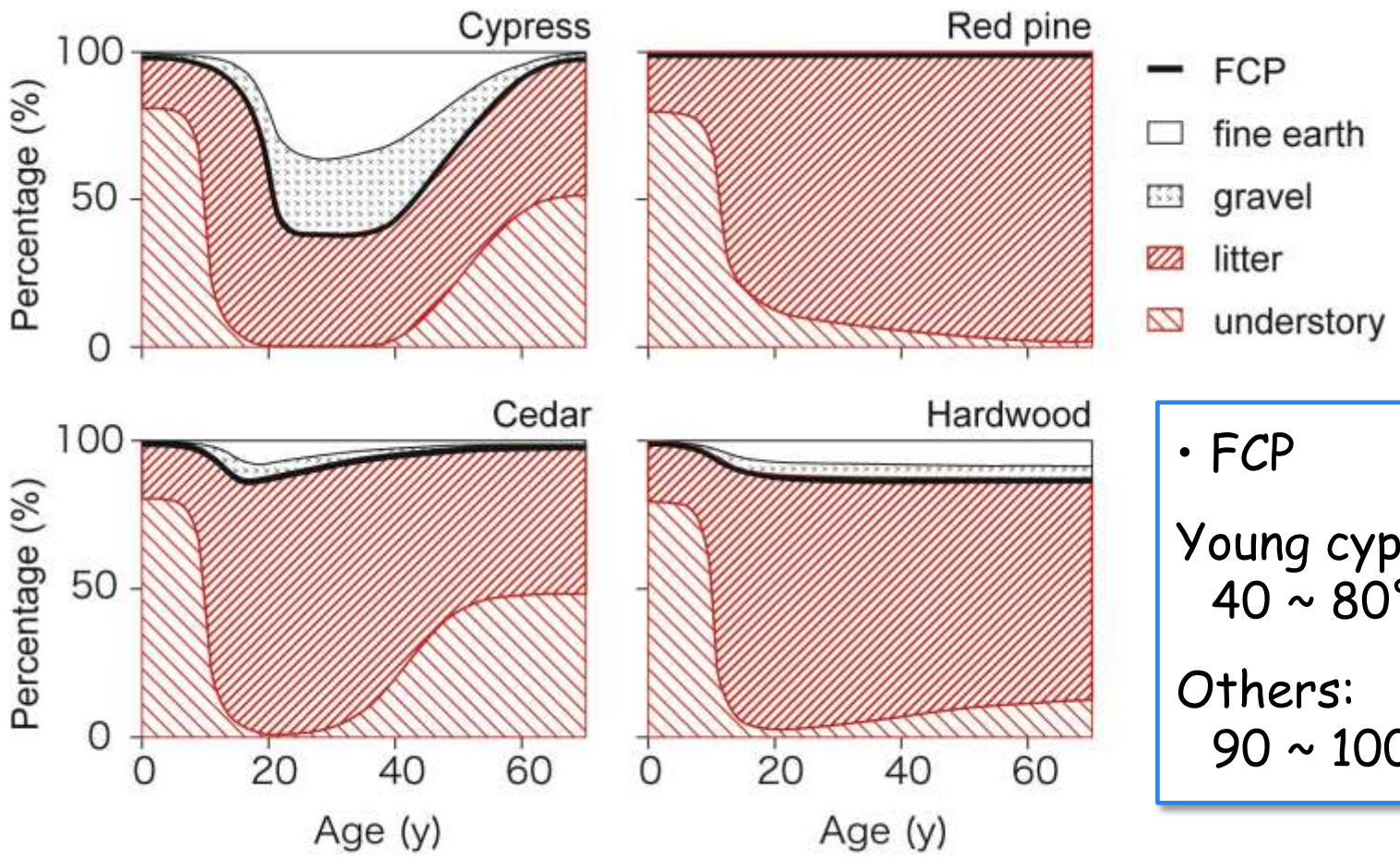


What factor? – Slope inclination, forest type





What factor? – Forest type and age



- FCP

Young cypress:
40 ~ 80%

Others:
90 ~ 100%

Miura (2000)

Forest Floor Cover Management is needed

- Soil is a regulating factor for ecosystem functions
- Losing floor cover, soil is quickly eroded
- Floor cover can be controlled by forest conditions

Base on these facts,

I am proposing a new concept of 'Forest Floor Cover Management' to protect soil from erosion

(-> this requires us to care about forest floor conditions along with crown cover of forests)

(-> measureable indicators should be introduced to national monitoring)

III. Monitoring soil erosion in National Forest Inventory (NFI)

Monitoring method for soil erosion in NFI

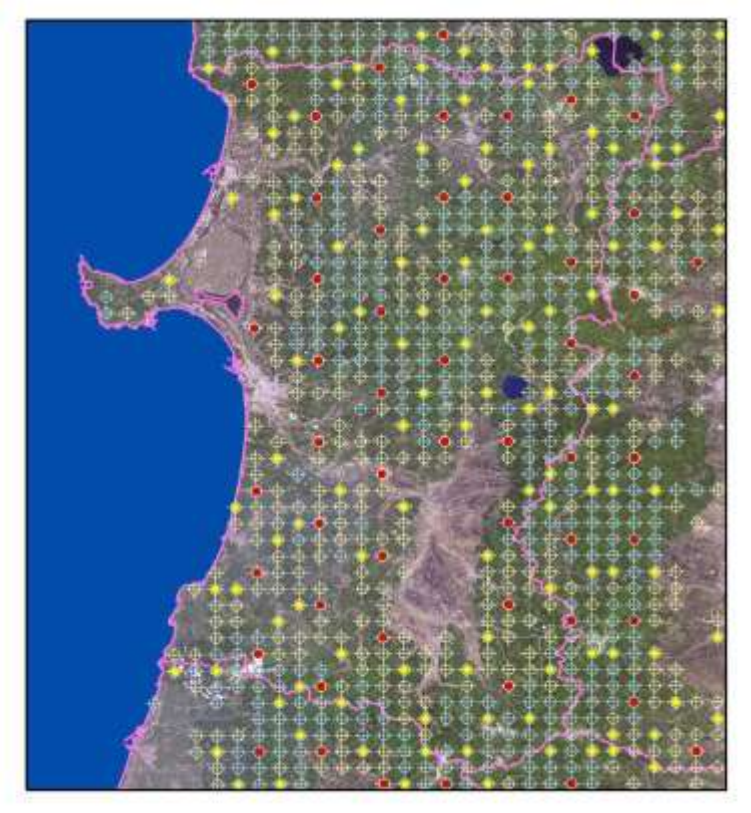
1999-2008 1st and 2nd rounds for NFI

2009-2014 3rd round for NFI

Quantitative, reproducible indicators

Location of plots in NFI and NFSCI

NFI, 4x4 km grid, 0.1ha
14,700 in Japan



(Akita pref.)

Definition of floor cover percentage

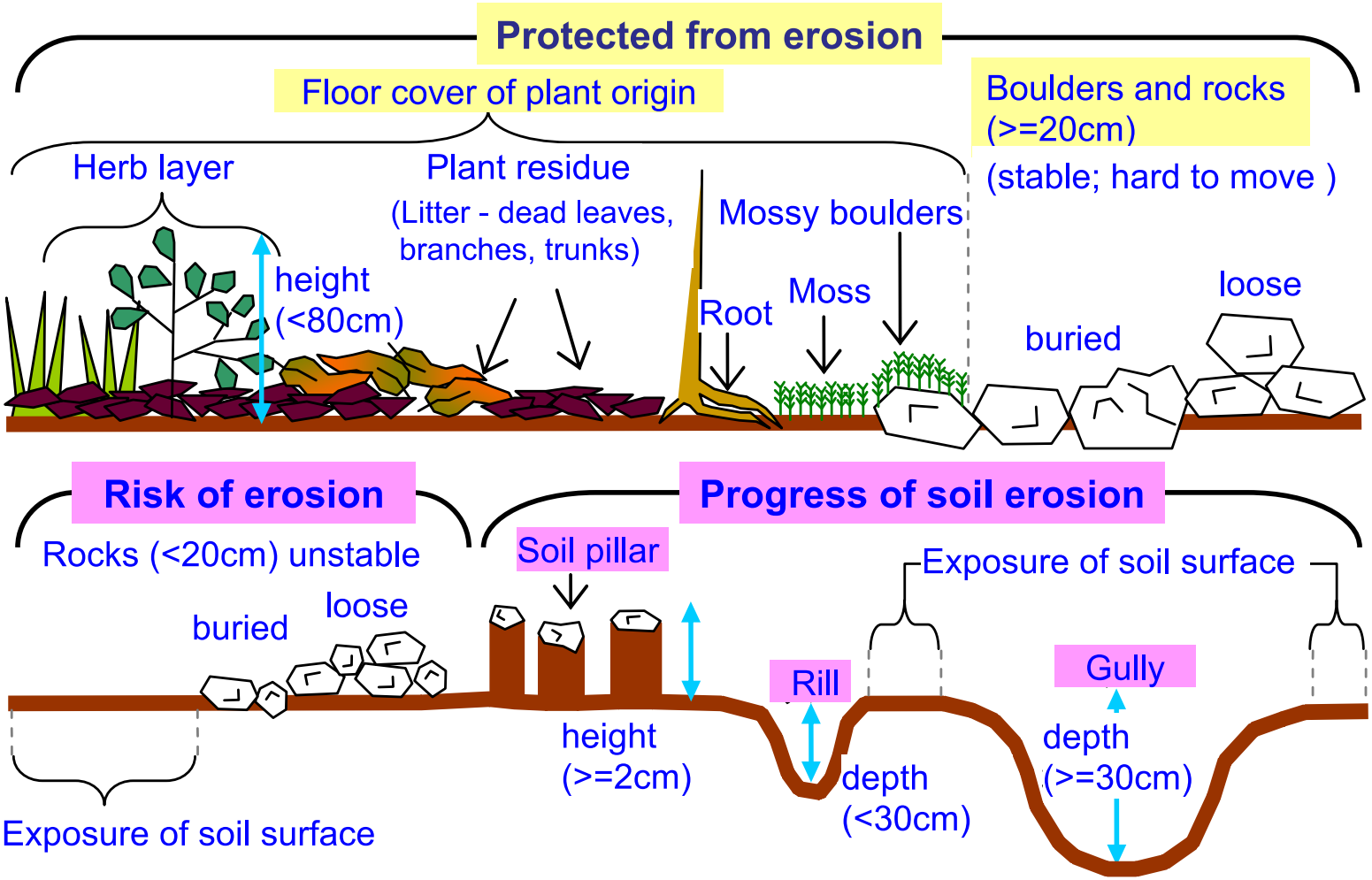
On 3rd round survey (2009),

two new indicators were introduced :

- Floor cover percentage (FCP) (cover by litter or understory) and percentage of boulders
- **Evidence** of erosion

} **floor coverage**

Scheme and definitions of two new erosion indicators in forest floor



Forestry Agency (2009)

Example of field survey

Field note

Very low cost

Percentage floor cover*	90	%
Percentage boulders *	0	%
Evidence of erosion	Soil pillar / Rill / Gully	

* Protective effect; visual judgment in 10% increments

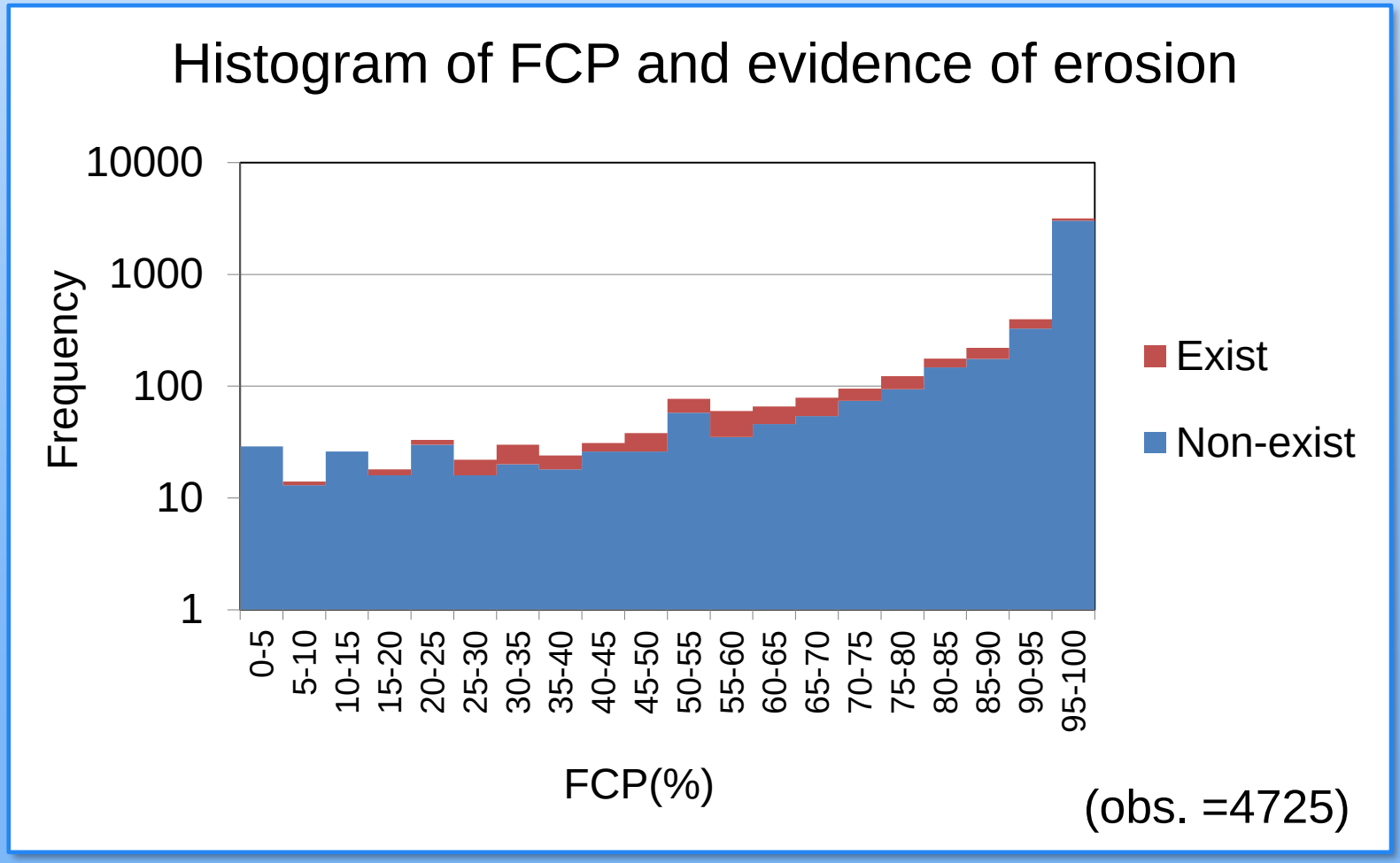
slightly severe < moderately severe < extremely severe

Duration,cost and reproducibility of new soil survey method

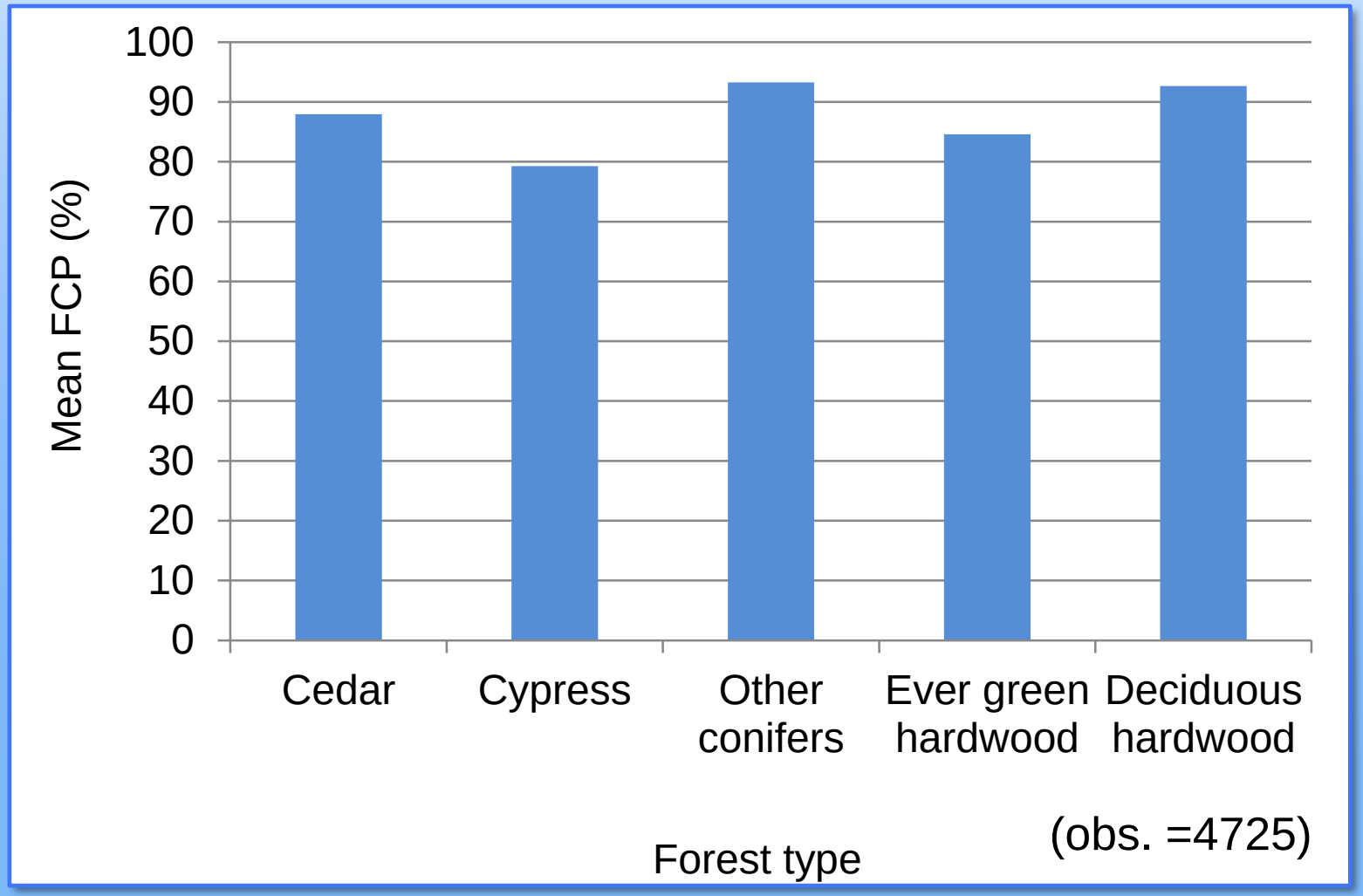
1. A few minutes for one plot survey
   → Almost no additional cost under NFI field survey
2. Reproducibility between contracted consultant surveys and control surveys by JAFTA in 2010 is as follows:

Percentage floor cover	94%
Percentage boulders	98%
Evidence of erosion	87%

FCPs >90% at 3/4 of plots
evidence of erosion appeared in 10% plots



FCP varies with forest types

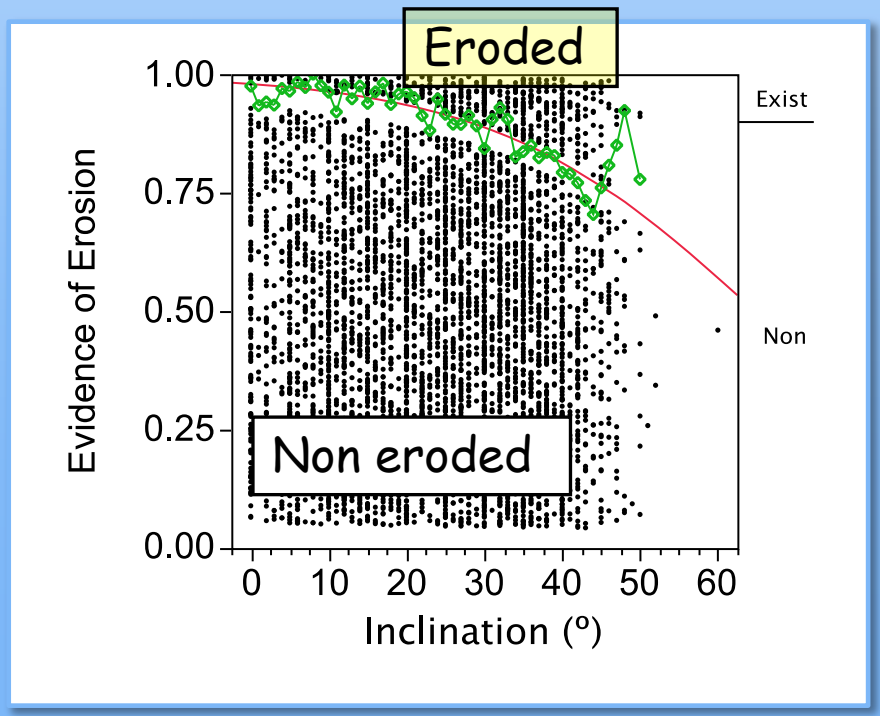


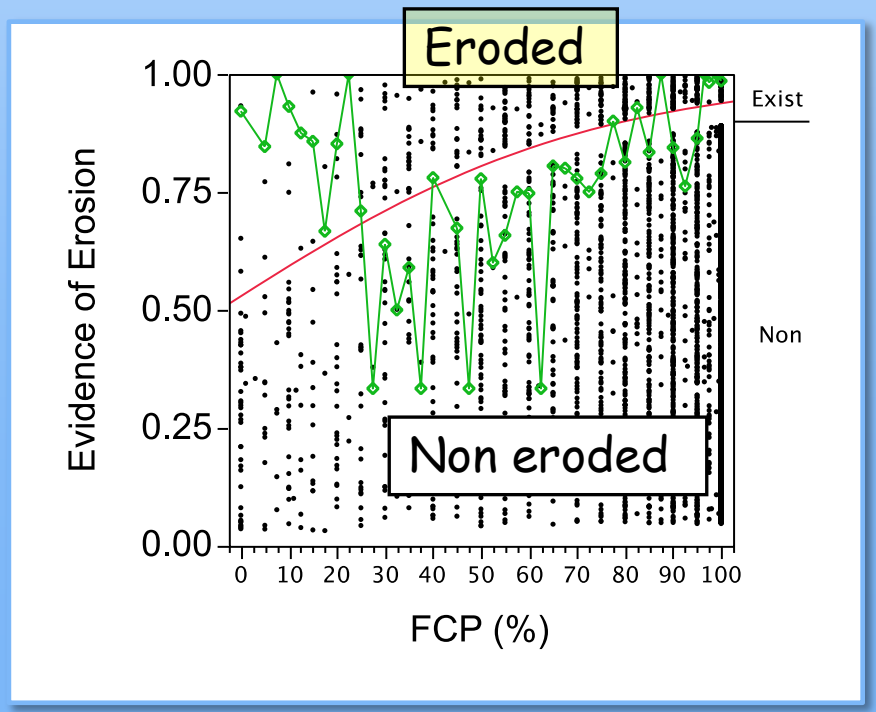
Evidence of erosion increases with slope, but decreases with FCP

Logistic regression between Slope inclination vs evidence of erosion

"FCP signs erosion"

Logistic regression between erosion





Observed (green)
Predicted (red)

(obs. =4725)

Summary of preliminary analysis of erosion data of NFI

1. New indicators were introduced into NFI
2. FCP was affected by forest type and age
3. Evidence of erosion was increased as increase of inclination and as decrease of FCP
4. A relationship likely exists among FCP, evidence of erosion

IV. Forest Floor Cover Management for Sustainable Forest Management

Rationale for Forest Floor Cover Management

SOIL FORMATION:

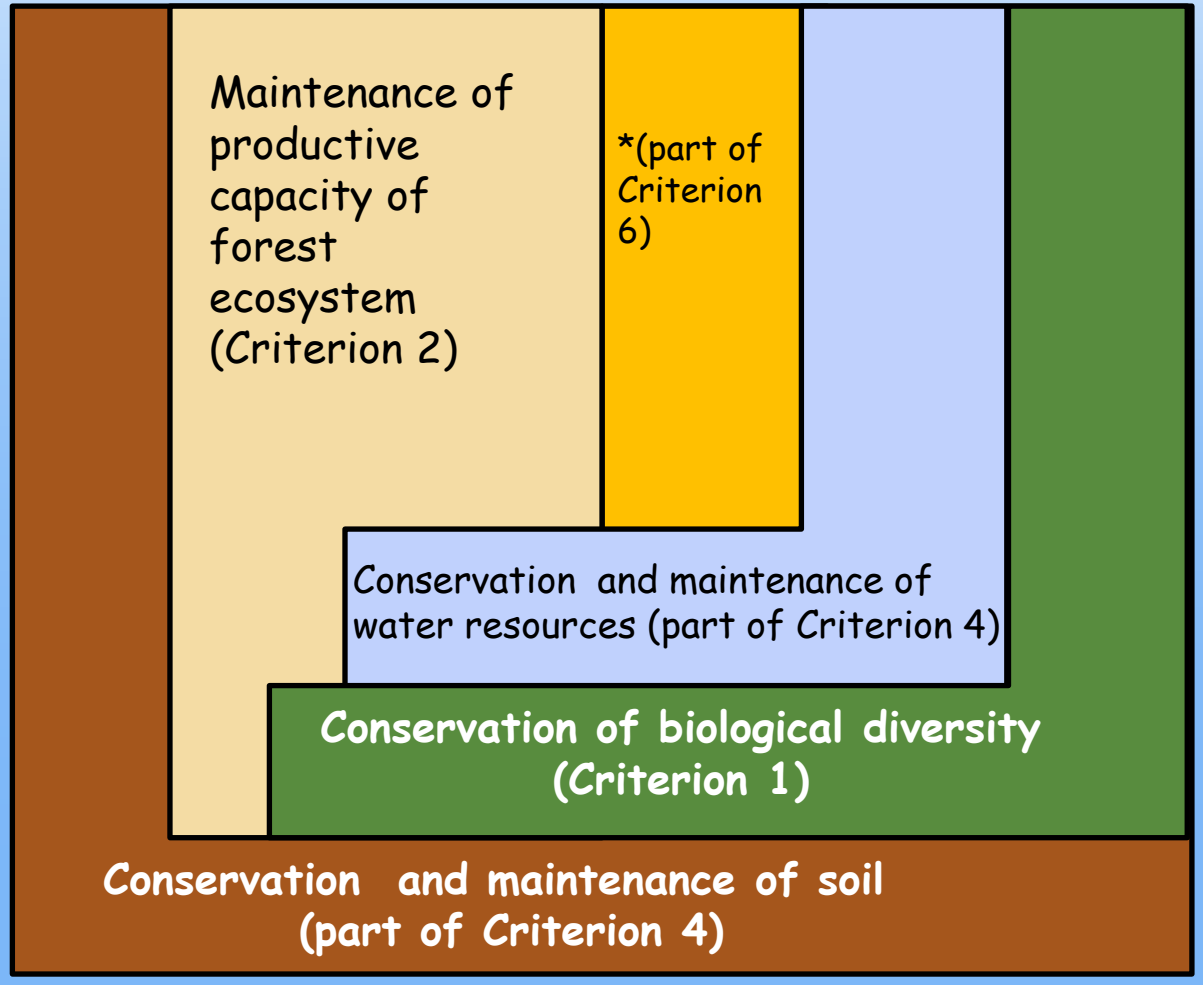
• Dead organic matters and living organisms are indispensable to soil formation

-> Soils must be preserved

TIME SCALE/SPAN RELATED SOIL

• We should remember the unbalanced time scale between formation and erosion of forest soil

Hierarchic structure of ecosystem services of forests



* Maintenance and enhancement of public recreation, tourism, cultural needs and values

Suzuki (1994, 2007), partly modified

Conclusion

- Forest soil should be protected from erosion because it regulate functions of ecosystem services

- Floor cover percentage (FCP) is a good indicator because it detects signs of soil erosion as a precautionary principle;
  - decrease of FCP triggers erosion
  - we can control FCP by management

- Accumulated data of FCP will be utilized to maintain forests sustainable

The forest floor is undoubtedly the most distinctive feature of a forest soil.

(Fisher and Binkley, 2000)