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Coastal pine forests damaged from the tsunami caused by the Great East Japan Earthquake

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Pine Species in Japan

P. densiflora
Japanese red pine

- *P. luchuensis*
- *P. parviflora*
- *P. pentaphylla*
- *P. pumila*
- *P. koraiensis*
- *P. armandii var. amamiana*

P. thunbergii
Japanese black pine

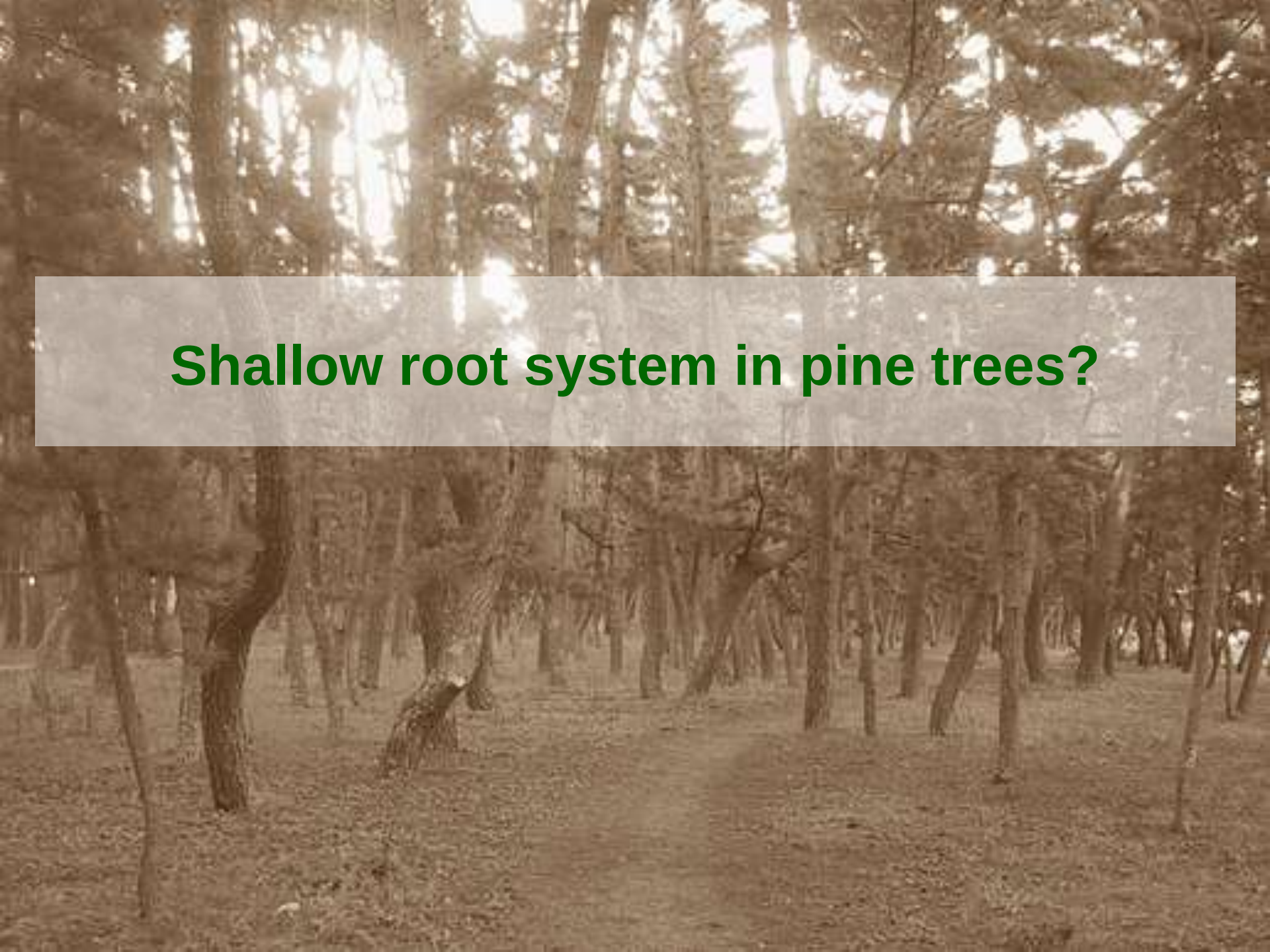
Takada-matsubara coastal pine forest blocked the drifting materials by an earthquake tsunami in 1960 (Photo by Agriculture, Forestry and Fisheries Department, Iwate Prefecture)

Is pine forest incompetent in coping with tsunami disaster?

Pine forest was washed out and disappeared after the tsunami following the great east Japan earthquake

Objection against reforestation of coastal pine forest

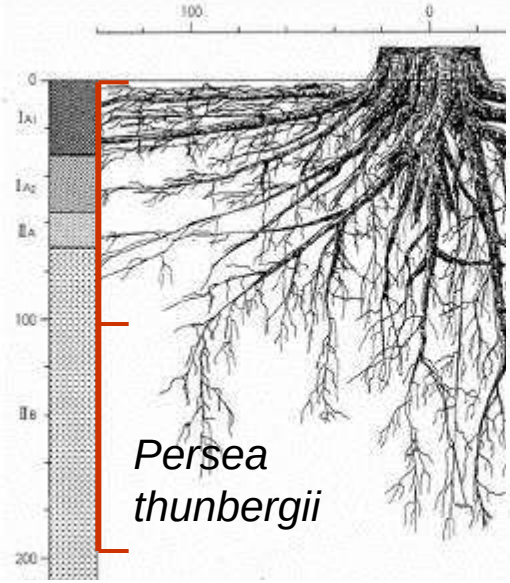
- Pine tree is not a member of **potential natural vegetation**
  - → Ideal natural forest can not be established under barren seacoast conditions
- Spread of pine trees is just a **result of excessive human activities**
  - → Pine forest is a form of correspondence of nature to the presence of human
- **Monoculture** of coniferous forest are weak to climatic / biological damage
  - → **Agree:** Diversity-oriented reforestation should be adopted
- Pine trees are selected only **for satisfying taste** in Japanese culture
  - → Pine plantation in seacoast sand dune is an attainment of our forefathers' desperate efforts
- Pine trees are not resistant to tsunami because of their shallow root system
  - ← Huge amount of pine trees was washed out from the root in various areas
- Pine trees are weak to seawater inundation
  - ← Occurrence of foliage discoloration of the remaining pine trees in the tsunami affected area

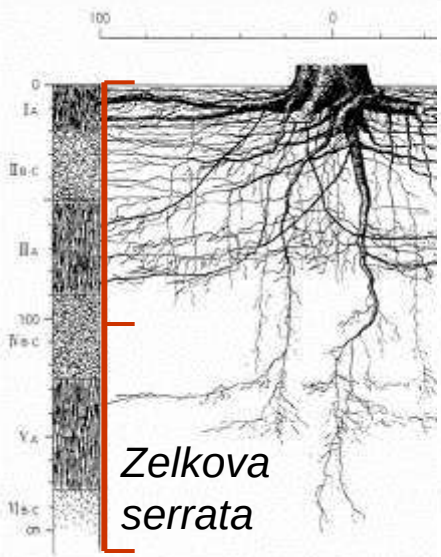

Shallow root system in pine trees?

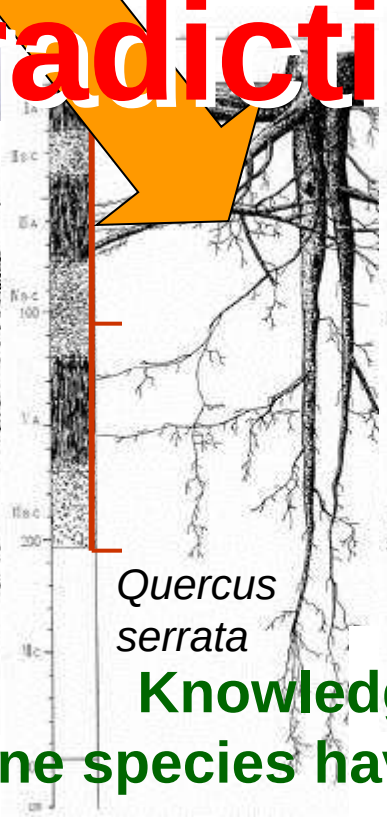
Uprooted pine trees showing shallow root system

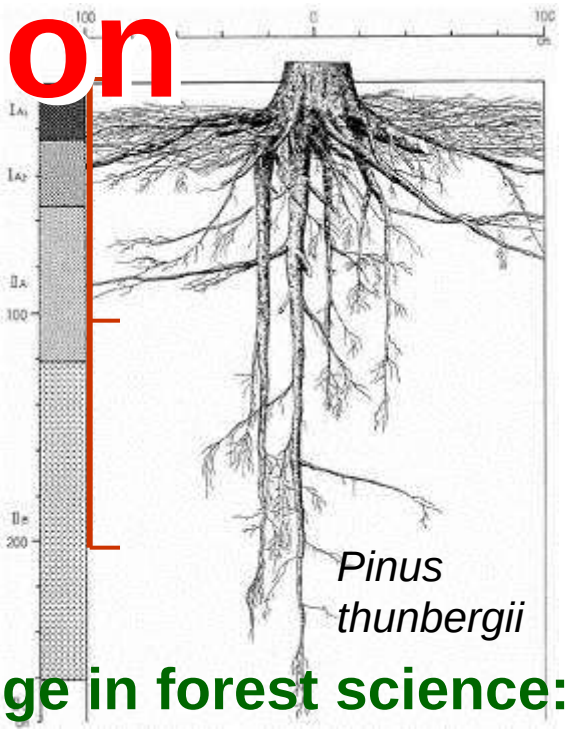
Prior knowledge: **cedar trees** have sallow root

contradiction









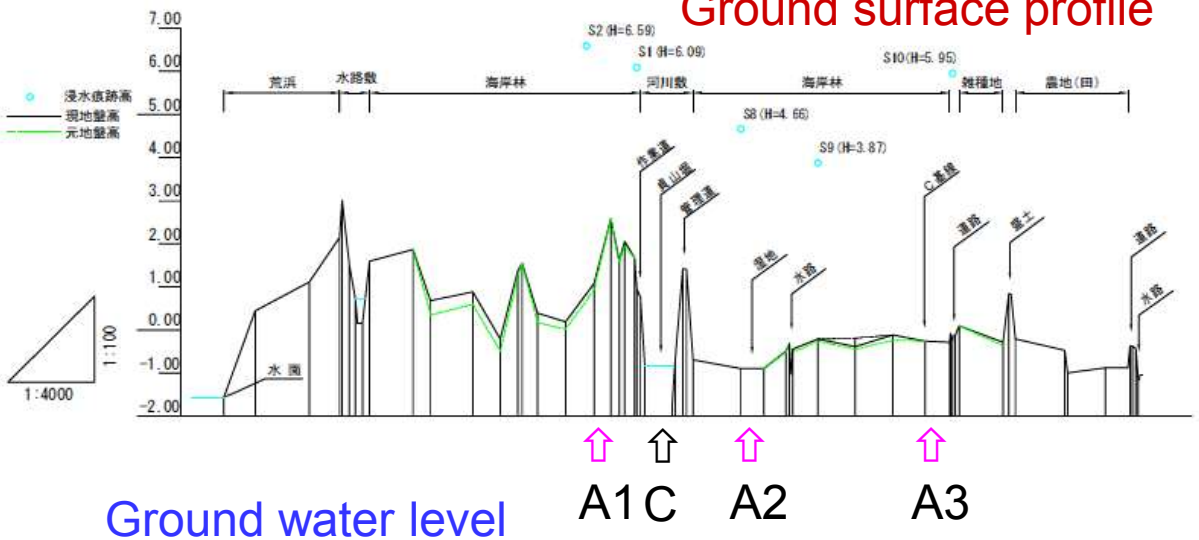
"Illustrations of tree roots"(Karizumi, 1987)

Knowledge in forest science: pine species have deep root system

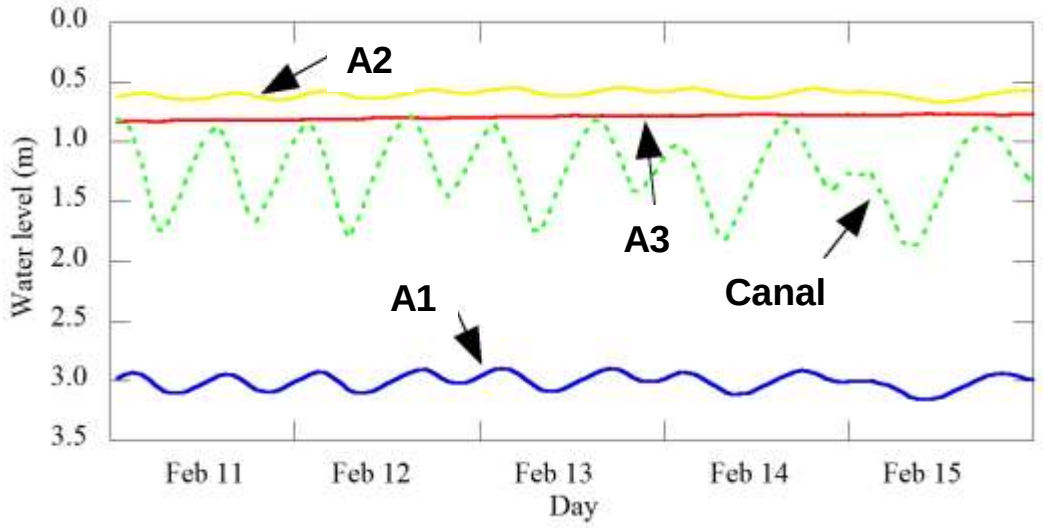
Factor(s) for the shallow roots

- High ground water level

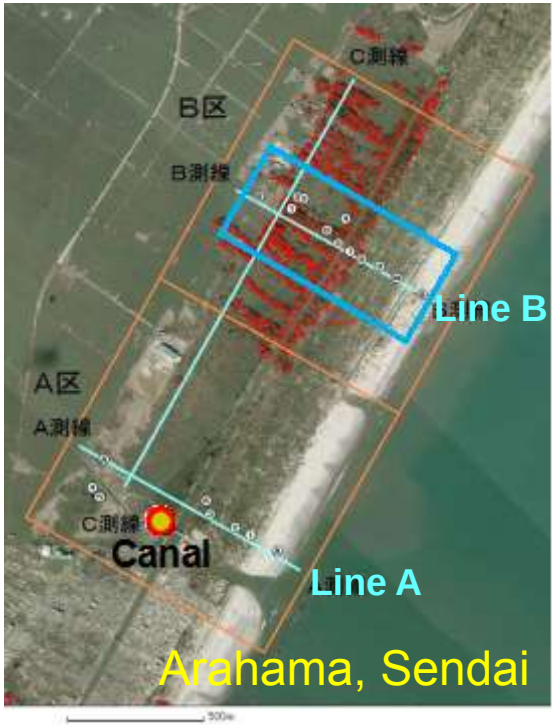
Ground surface profile



Ground water level



Data by Shoji NOGUCHI (FFPRI)



- Preparation of the planting seedling

Shallow root system in pine trees?

- Pine trees (conifers) are shallow ⇔ Broad-leaved trees are deep

➔**False**

- Root of pine trees can't penetrate deep in the ground when ground water level is high

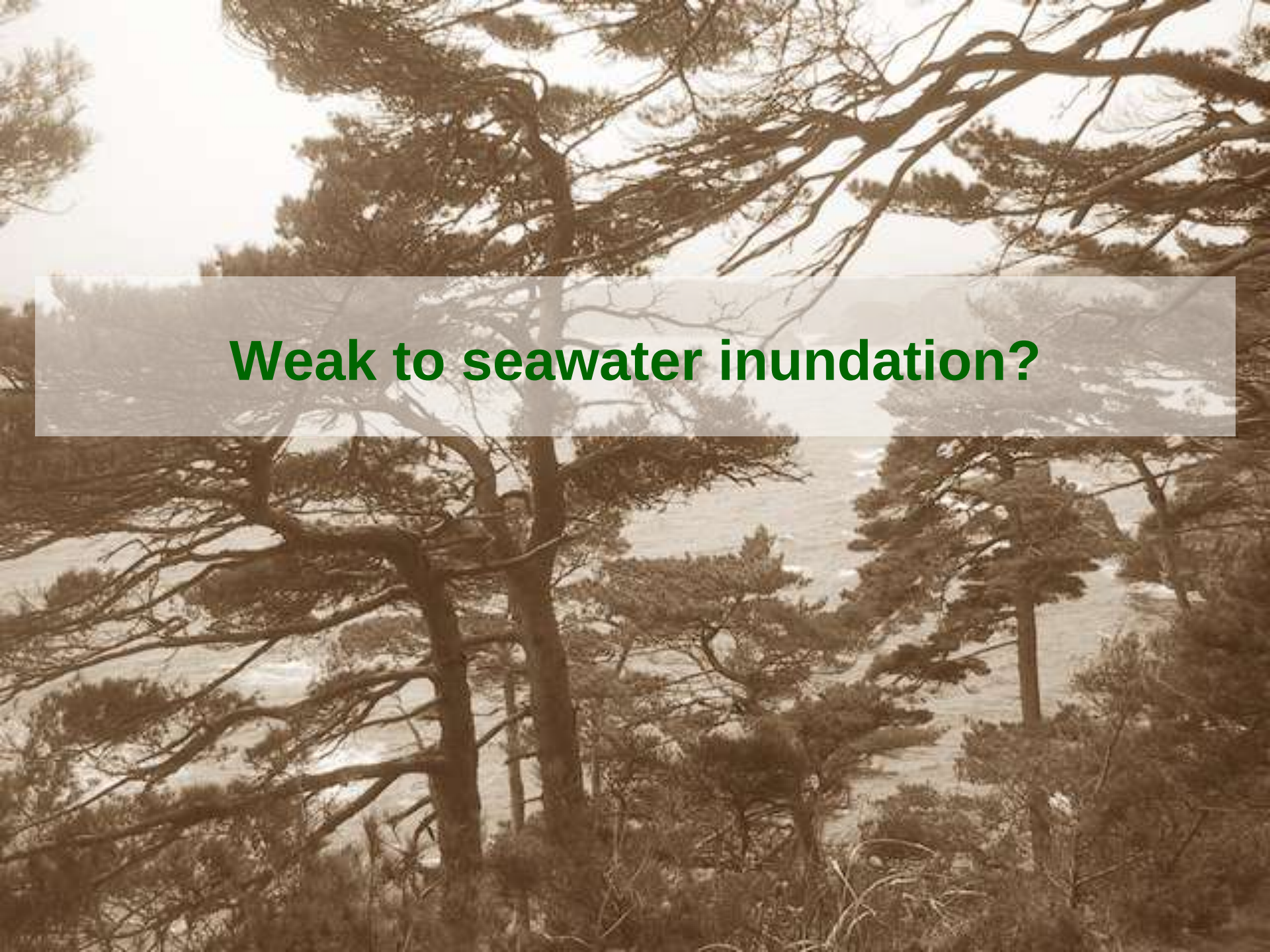
➔**True**

No difference between pine and broad-leaved trees

- Pine trees are not resistant to tsunami and shall be replaced by broad-leaved trees

➔**Incorrect**

- Pine roots were **strong enough** to resist the tsunami and broken at the stem
- No trees can be resistant to the extremely powerful tsunami: **irrespective of species**


Weak to seawater inundation?

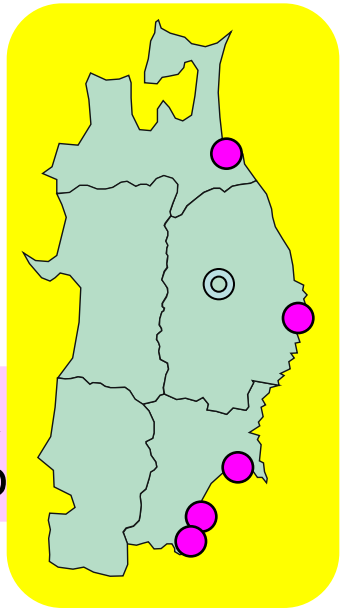
Foliage discoloration in the tsunami-damaged pine trees

Species of pine tree

P. thunbergii
P. densiflora

Difference in places

Temporal cha
(Develop/reco

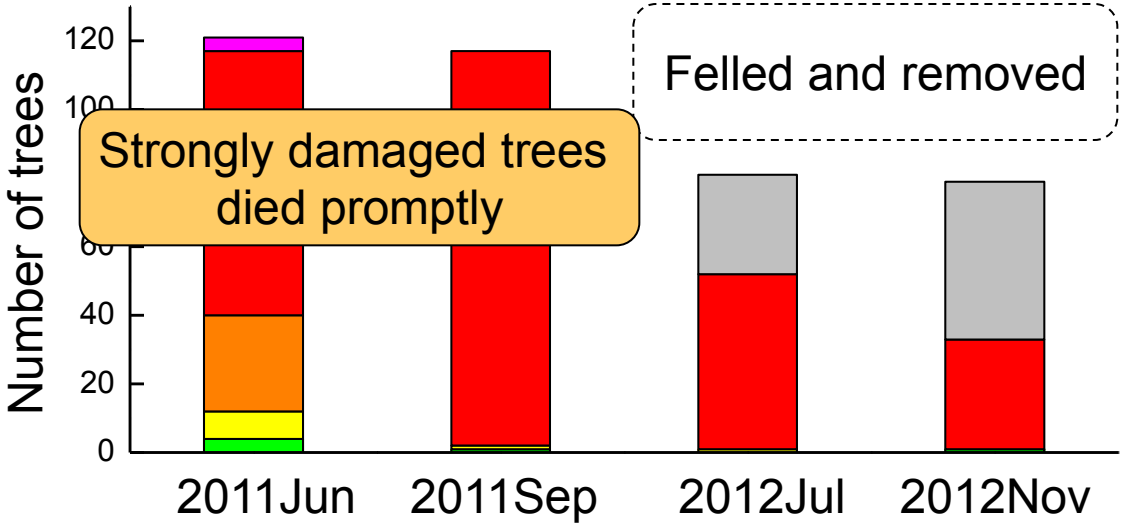


Factors other than tsunami-damage

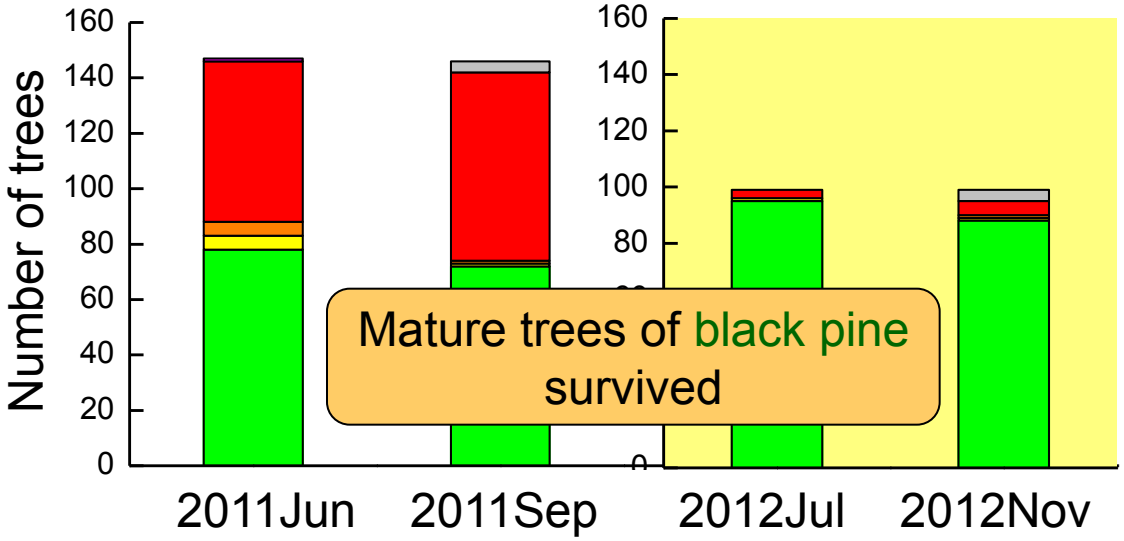
Conclusion

Weak to seawater inundation!

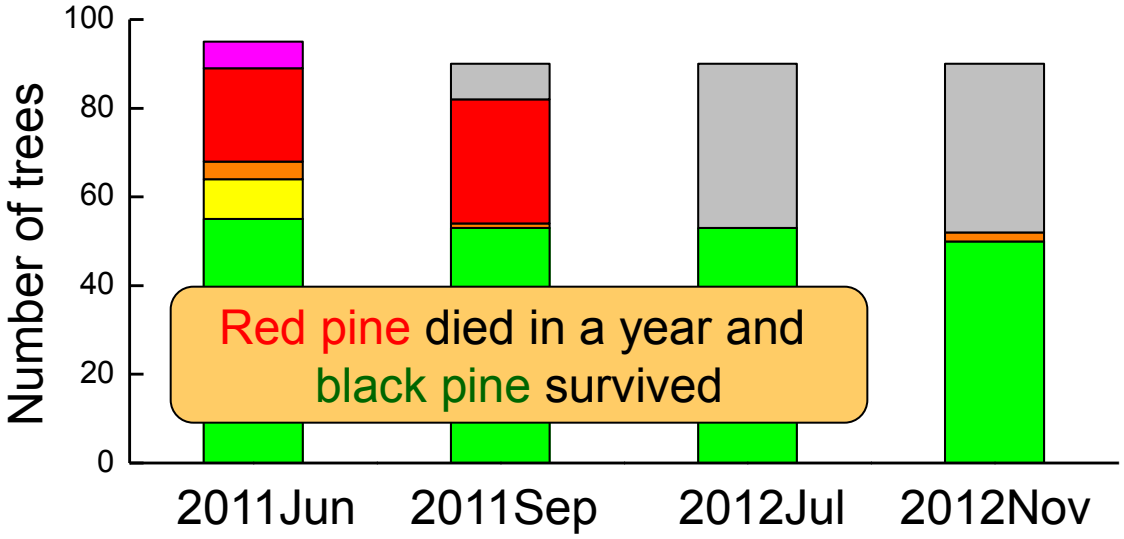
Front-line stand of black pine (Watari, Miyagi Pref.)



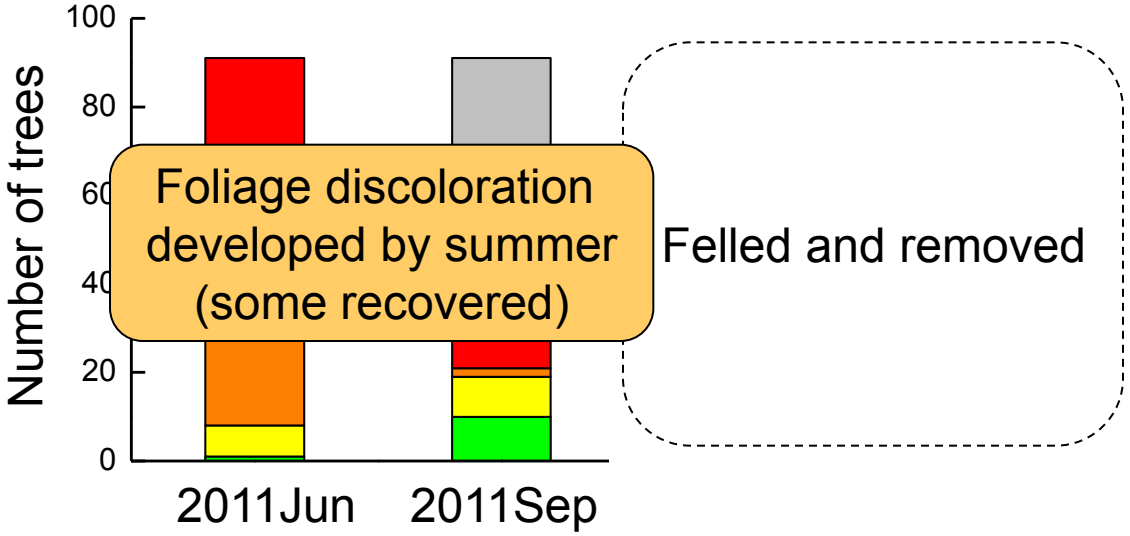
Backward stand of black and red pine (Watari, Miyagi Pref.)



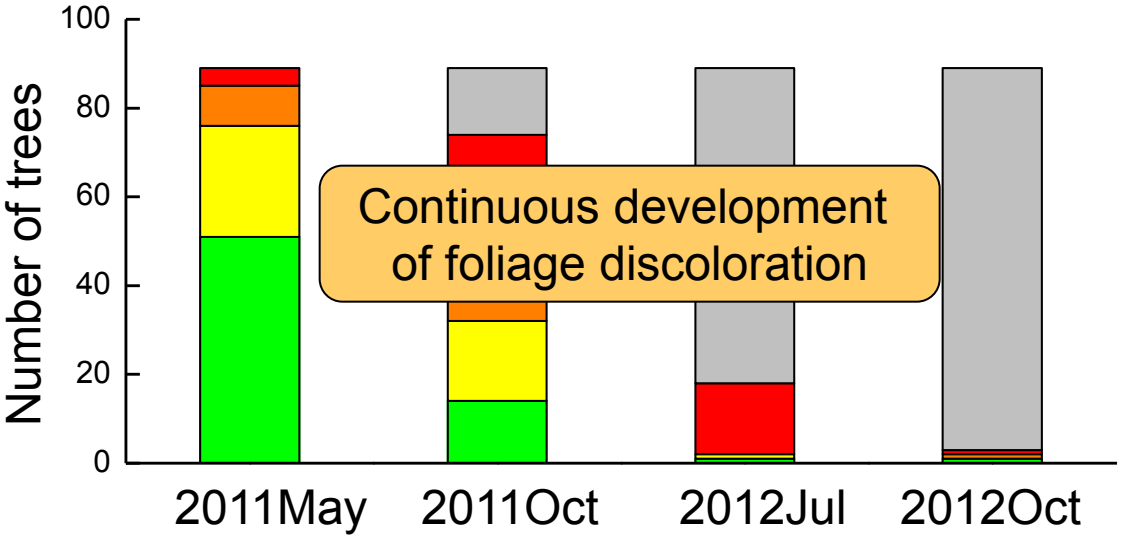
Backward stand of black and red pine (Yamamoto, Miyagi Pref.)



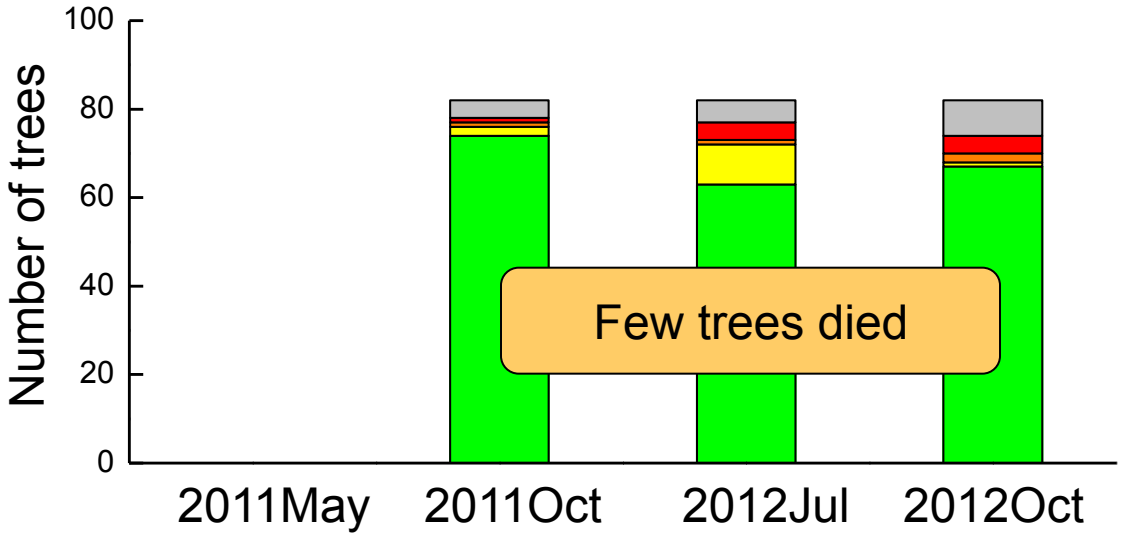
Backward stand of mature red pine (Higashi-matsushima, Miyagi Pref.)



Backward stand of black pine #1 (Hachinohe, Aomori Pref.)



Backward stand of black pine #2 (Hachinohe, Aomori Pref.)



Weak to seawater inundation?

- Pine trees accounted for most of the dead trees in tsunami damaged area, BECAUSE most of seacoast forest had been consisted of pine trees exclusively.

- In many cases, mature *P. thunbergii* trees survived after tsunami disaster.

- Strongly damaged trees and small shaded trees were prone to die shortly after the tsunami. Ill-drained condition of the soil may have caused death in mature *P. thunbergii* trees.
- Many of *P. densiflora* trees died in the tsunami flooded area, but the declining process looked slow-advancing.

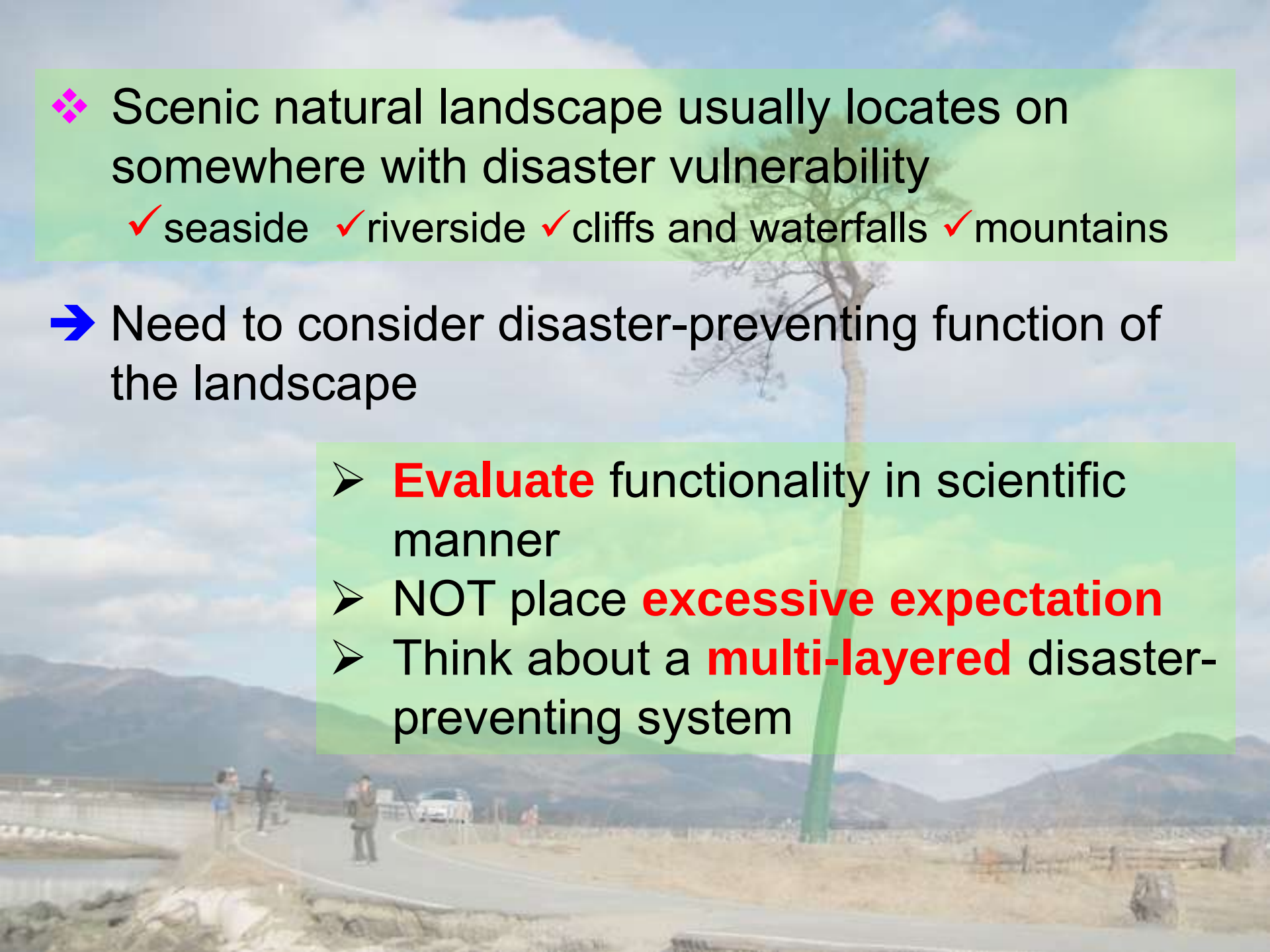
- Skepticism about the competence of pine trees in seacoast forest is based on misunderstanding
  - ✓root system ✓vulnerability to seawater inundation

➔Need to avoid hasty conclusions

- Seacoast pine forest had some critical deficits in coping with tsunami disaster
  - ✓High ground water ✓drainage ✓vulnerable red pines

➔Need to be improved

- Optimized use of pine and other tree species should be pursue to provide the seacoast forests with enhanced functionality and robustness



- Scenic natural landscape usually locates on somewhere with disaster vulnerability
  - ✓seaside ✓riverside ✓cliffs and waterfalls ✓mountains

→ Need to consider disaster-preventing function of the landscape

- **Evaluate** functionality in scientific manner
- NOT place **excessive expectation**
- Think about a **multi-layered** disaster-preventing system

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