Spatial Distribution of Trees

Makiko Oda
Graduate School of Environmental Science, Okayama University
Fumio Ishioka
School of Law, Okayama University
Koji Kurihara
Graduate School of Environmental Science, Okayama University

Content

- Purpose
- Target Forest
- Data
- Forest Structure
- Voronoi Diagram
- Echelon Dendrogram
- Patch detection
- Conclusion

Purpose

- ”Forest monitoring” are conducted in many forests for a long term.
- Most of these forests studies focused on tree distributions.
- We newly developed Echelon analysis as an analysis method from a hierarchic structure point of view.
  - ➡ We developed patch detection in forest using Echelon Dendrogram.

Target Forest

- Data are in Forest Dynamics Data Base which had been compiled by the Forestry and Forest Products Research Institute.
- We focused on Ogawa Forest Reserve because this forest data have many information of trees.
- The site is a square of 300m × 200m (6ha).
- We focused on mature trees.

Ref. FDDB http://fddb.ffpri-108.affrc.go.jp/index.html

Data

Coordinate　　Individual ID　　Girth

About 5000

Species	X	Y	IND_ID	GBH
Acer mono	12.08235	197.9678	2	97.8
Acer nikoense	10.35074	185.4226	16	16.5
Carpinus cordata	15.52746	182.8161	17	15
Swida controversa	17.90099	182.9994	20	132.9
…	…	…	…	…
Quercus serrata	295.3504	4.818616	5885	62.1

Data : GBH

- Girth at Breast Height
  - ➡ Each tree girth is measured at 1.3m.
- Advantage
  - ➡ There is an allometry equation between a breast height diameter and tree height.
  - ➡ "GBH" is used as a tree size.

$$\frac{1}{H_{i,t}} = \frac{1}{\alpha_t D_{i,t}^{\ h_t}} + \frac{1}{H_{\max t}}$$

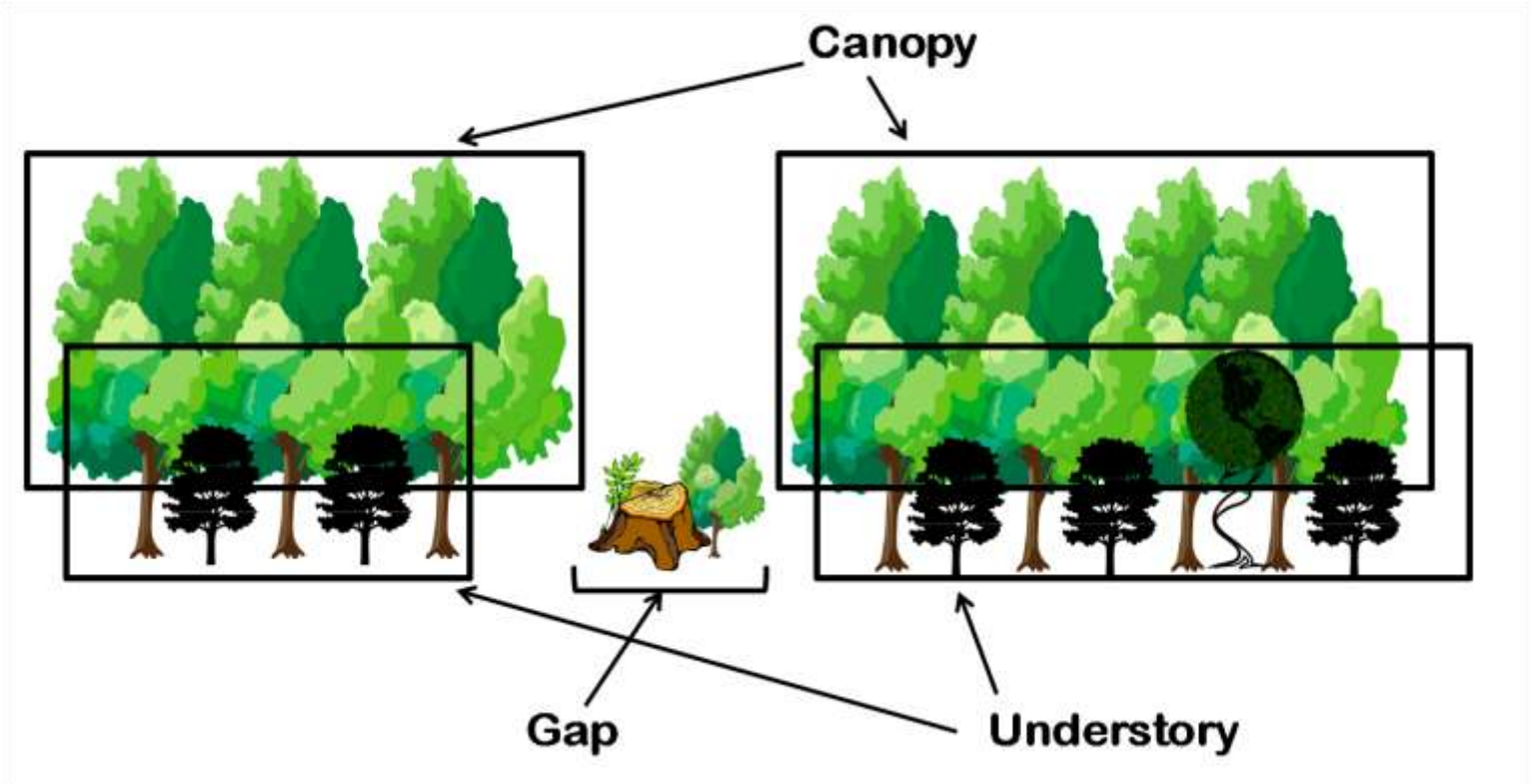
$H_{i,t}(m)$: i - th tree height of species t

$D_{i,t}(cm)$: i - th breast height diameter of species t

$\alpha_t, h_t, H_{\max}$: each constant

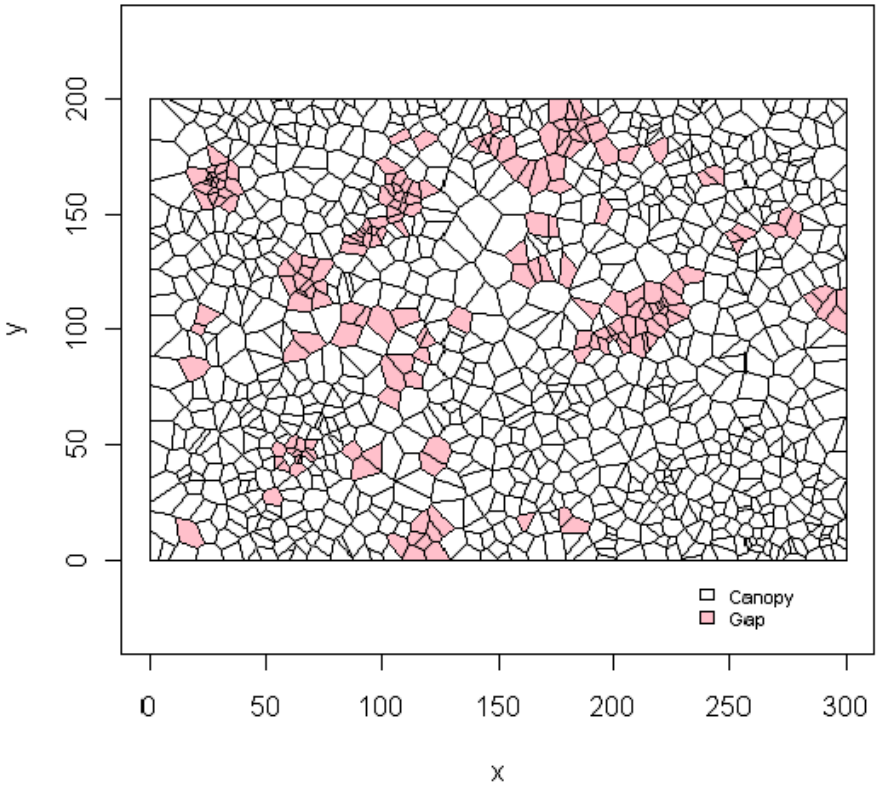
Forest Structure

- The forest has two kinds of layers.
  - ➡ a upper layer, canopy; a under layer, understory
- There are gaps which divide layers of canopy and understory.



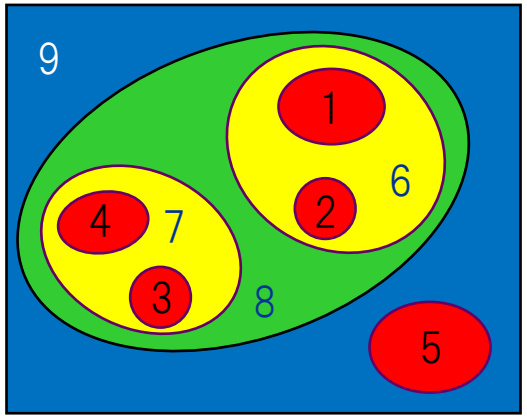
Voronoi Diagram

- Tree locations are point data.
  - ➡ change to regional data using Voronoi diagram.
- This Voronoi Diagram made from canopy trees and trees in a gap.
- Each Voronoi region shows an occupied area by canopy tree.
  - ➡ Canopy layers have no room except a gap.

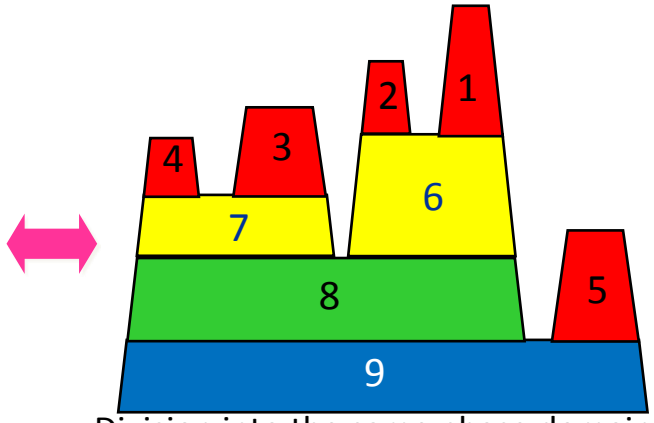


Echelon Dendrogram

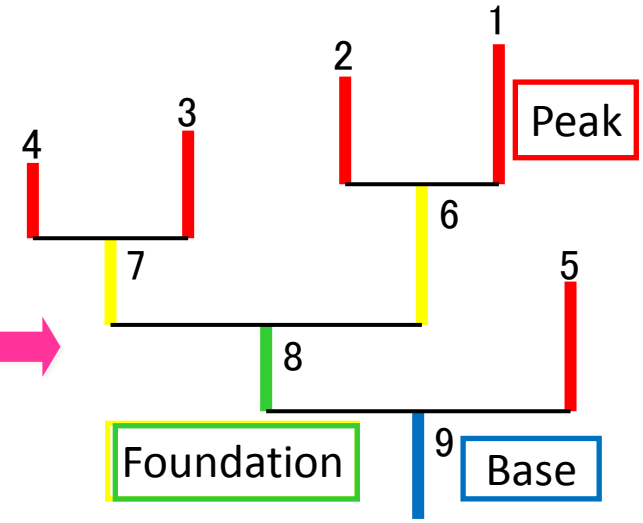
- Echelons are based on the areas of relative high and low values of response variables of spatial data.
- The echelon approach gets together the areas in which the values have the same topological structure and makes hierarchically related structure of these areas.
- Echelon Dendrogram is the graph that shows hierarchically the structure.



Tow dimensional data sorted by surface value



Division into the same phase domain in Echelon analysis



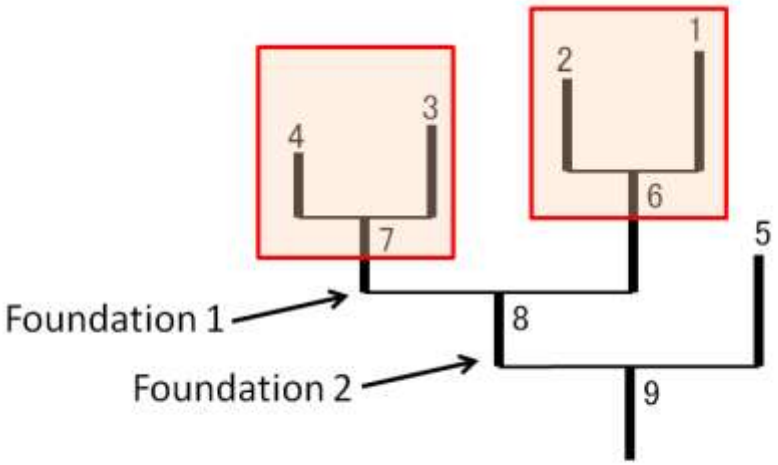
Echelon dendrogram

Patch Detection

- It takes about 50 years to change whole forest.
  - ➡ Small changes occur by fall-tree or grow-up tree.
  - ➡ We take notice of a patch.
- Patch definition（Forman et al., 1986）
  - ➡ A nonlinear surface area differing in appearance from its surroundings.
- Many kinds of forest consist of mosaic structure of patches.（Nakashizuka, 1987）
  - ➡ Patches detection by using Echelon Dendrogram is useful.
  - ➡ Existing method is not objective such as appearance check.

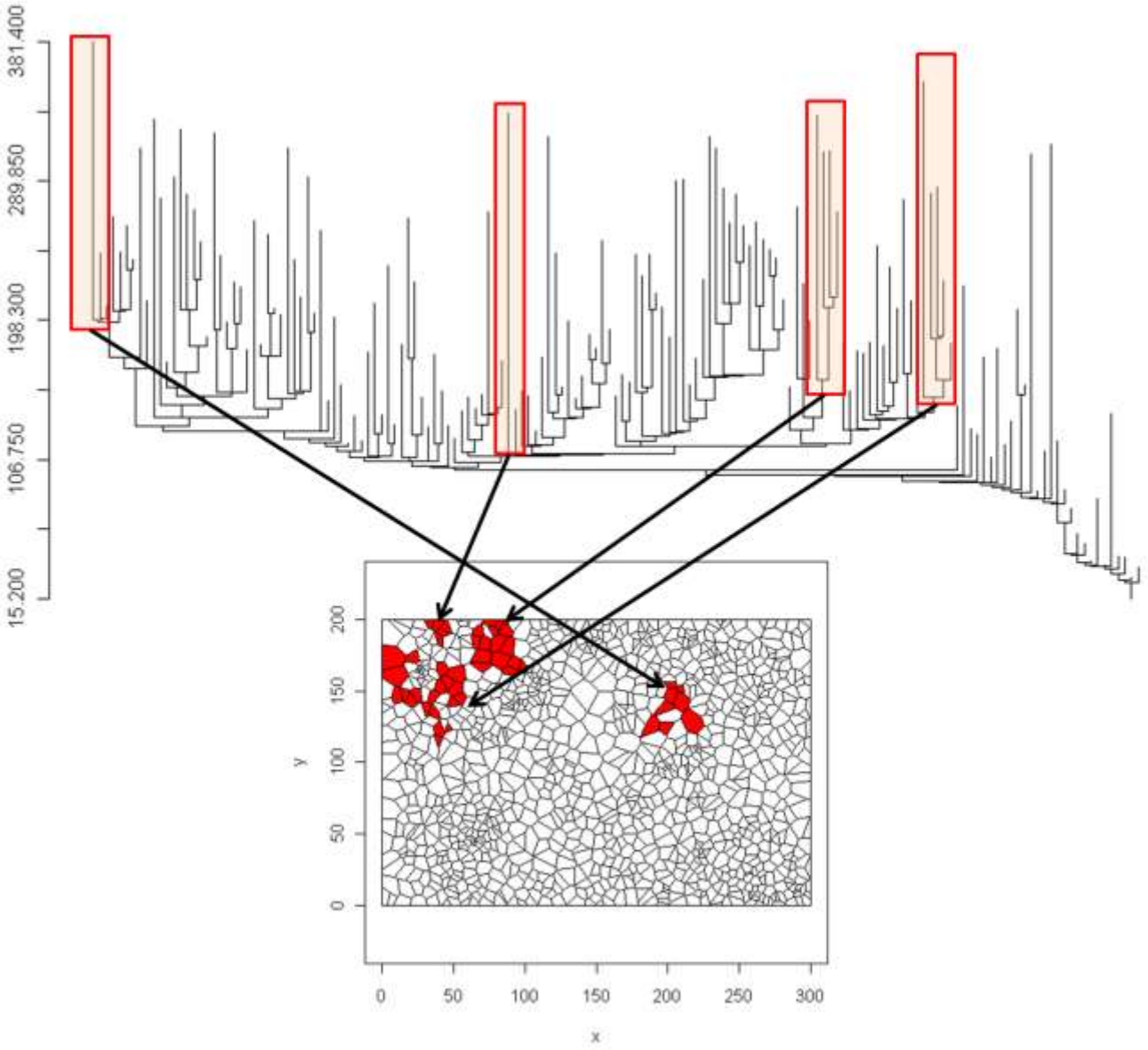
Patch Detection

- A patch is detected on the basis of bigger tree.
  - ➡ Echelon Dendrogram is made based on neighboring information.
- [EN5] does not view a patch.
  - ➡ A patch is too large.



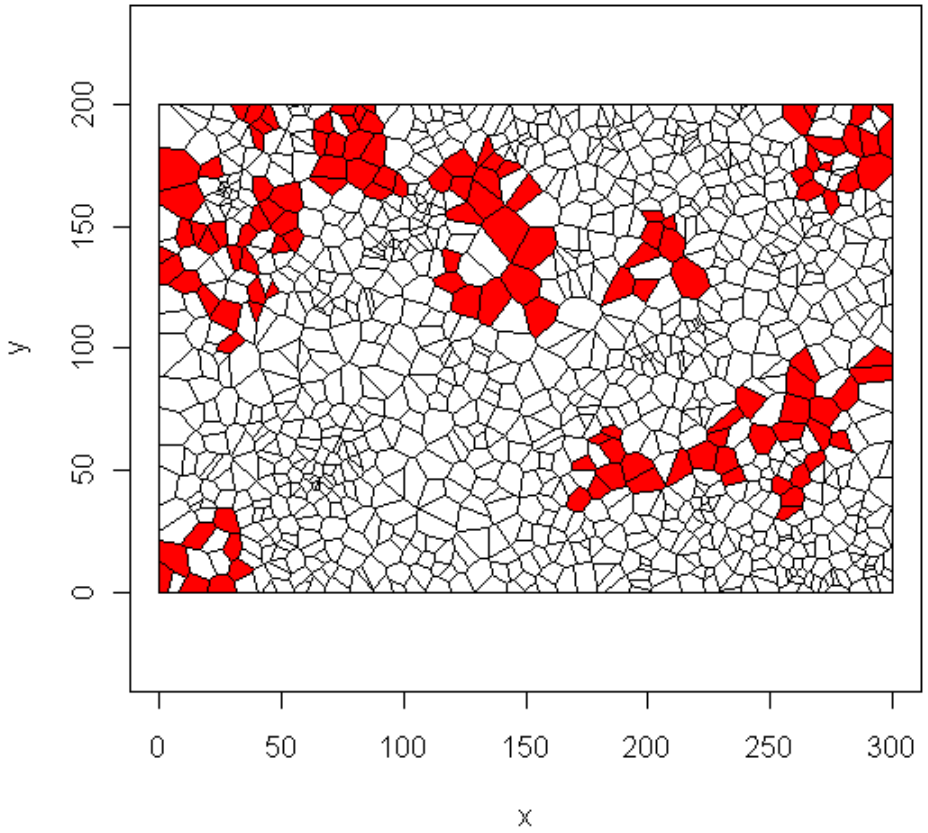
Echelon dendrogram

Patch Detection



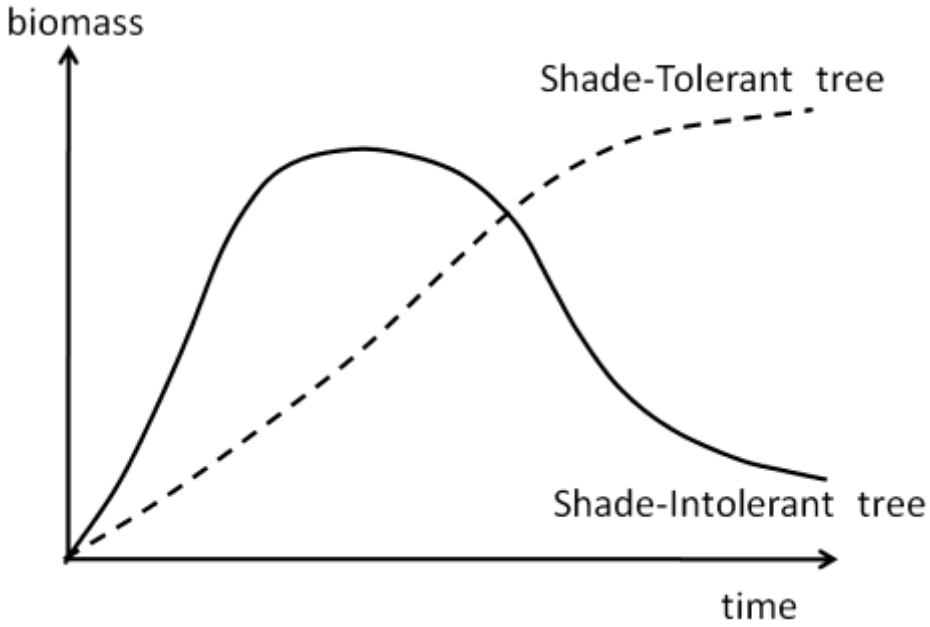
Canopy : Patch Detection

- A forest has two layers.
  - ➡ Parches were detected in each layer.
- 10 patches were established based on larger trees in peaks.
- Patch shapes are irregular.



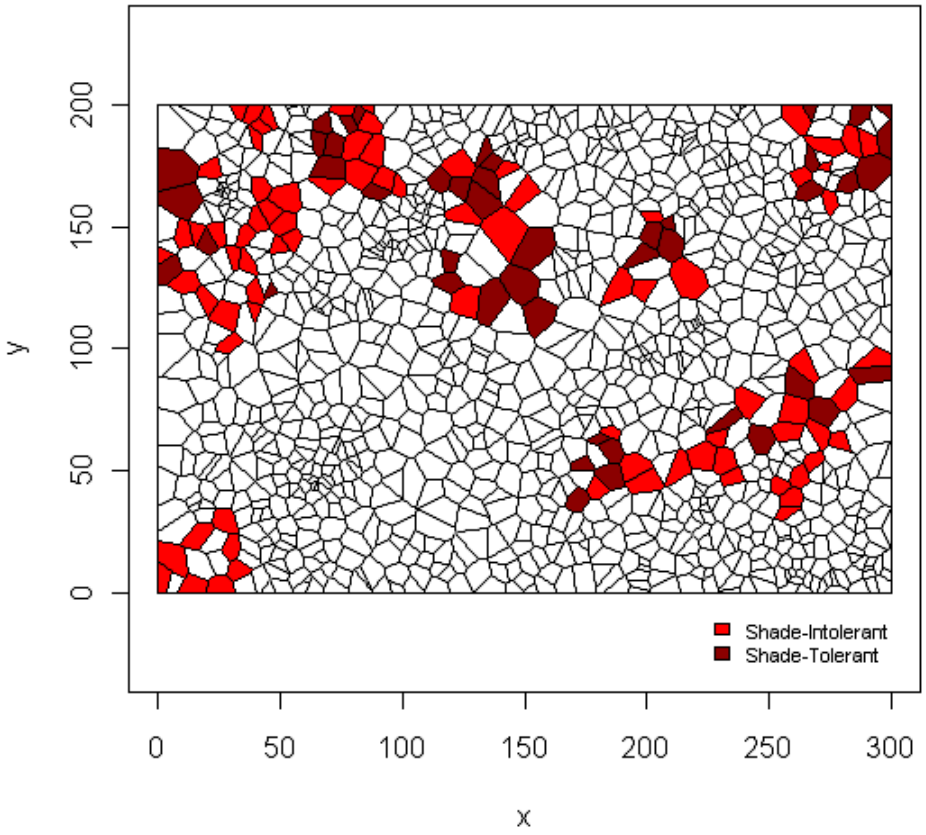
Canopy : Patch Detection

- In general, a tree is classified according to shade tolerance.
  - ➡ Shade-Intolerant
  - ➡ Shade-Tolerant
- Shade-Tolerant tree biomass increases with time.



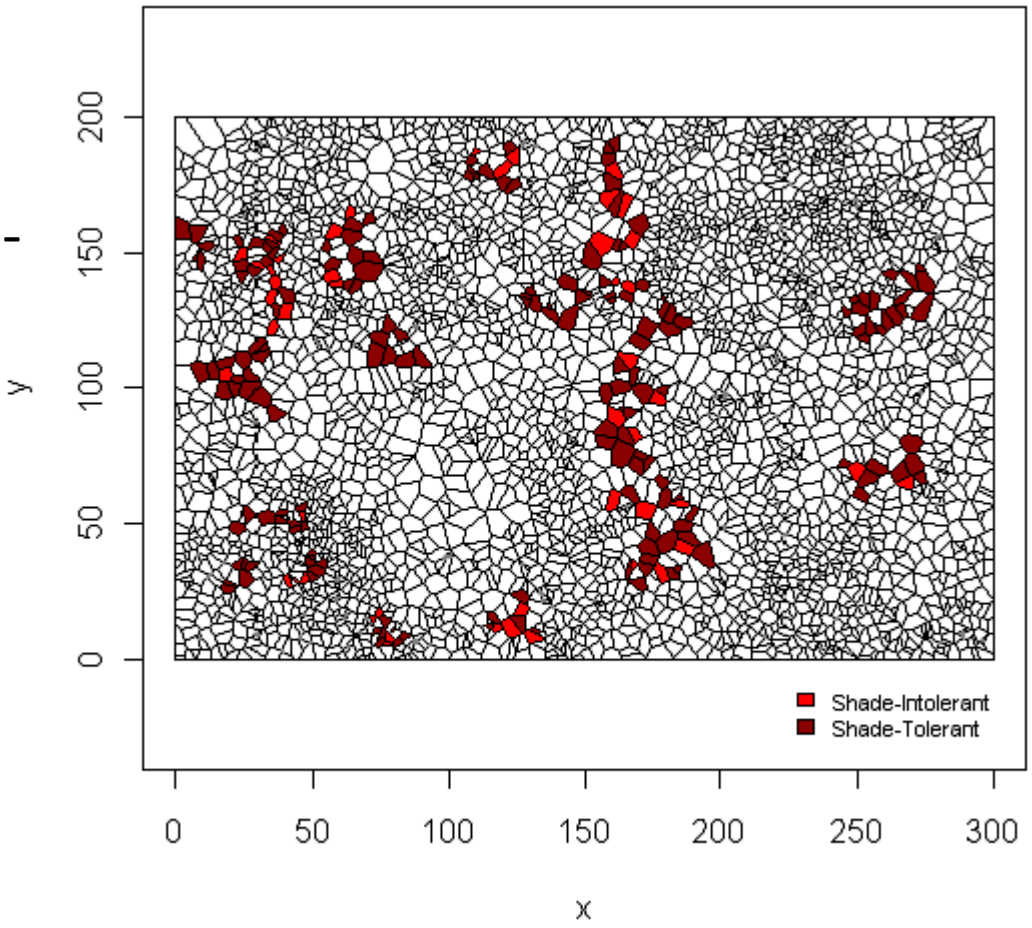
Canopy : Patch Detection

- Shade tolerance is added in each patch.
  - Distributions of Shade-Tolerant trees and Shade-Intolerant trees were not regulation in patches.
  - This forest may be at transition stage.



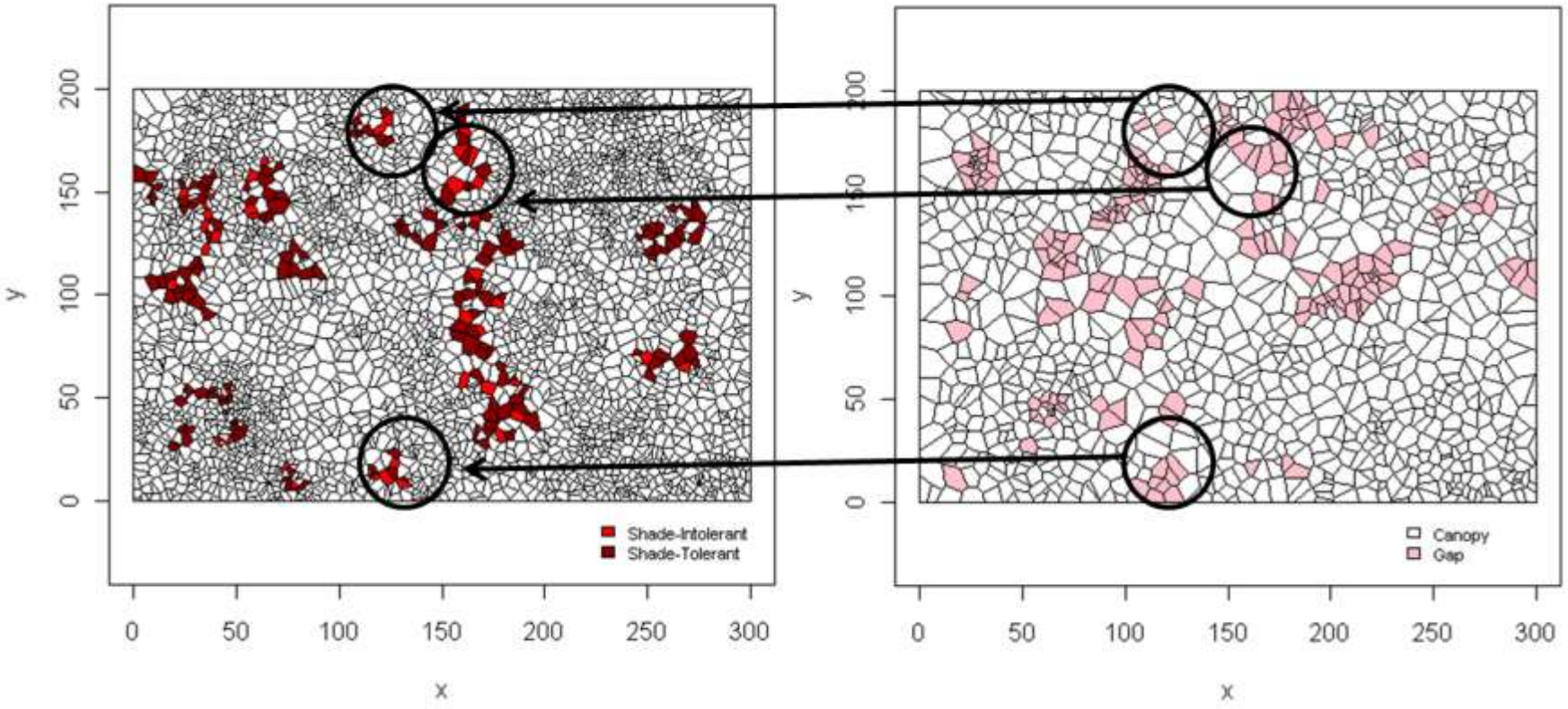
Understory : Patch Detection

- 20 patches are similarly detected in understory.
  - Most of trees are Shade-tolerant because of understory.



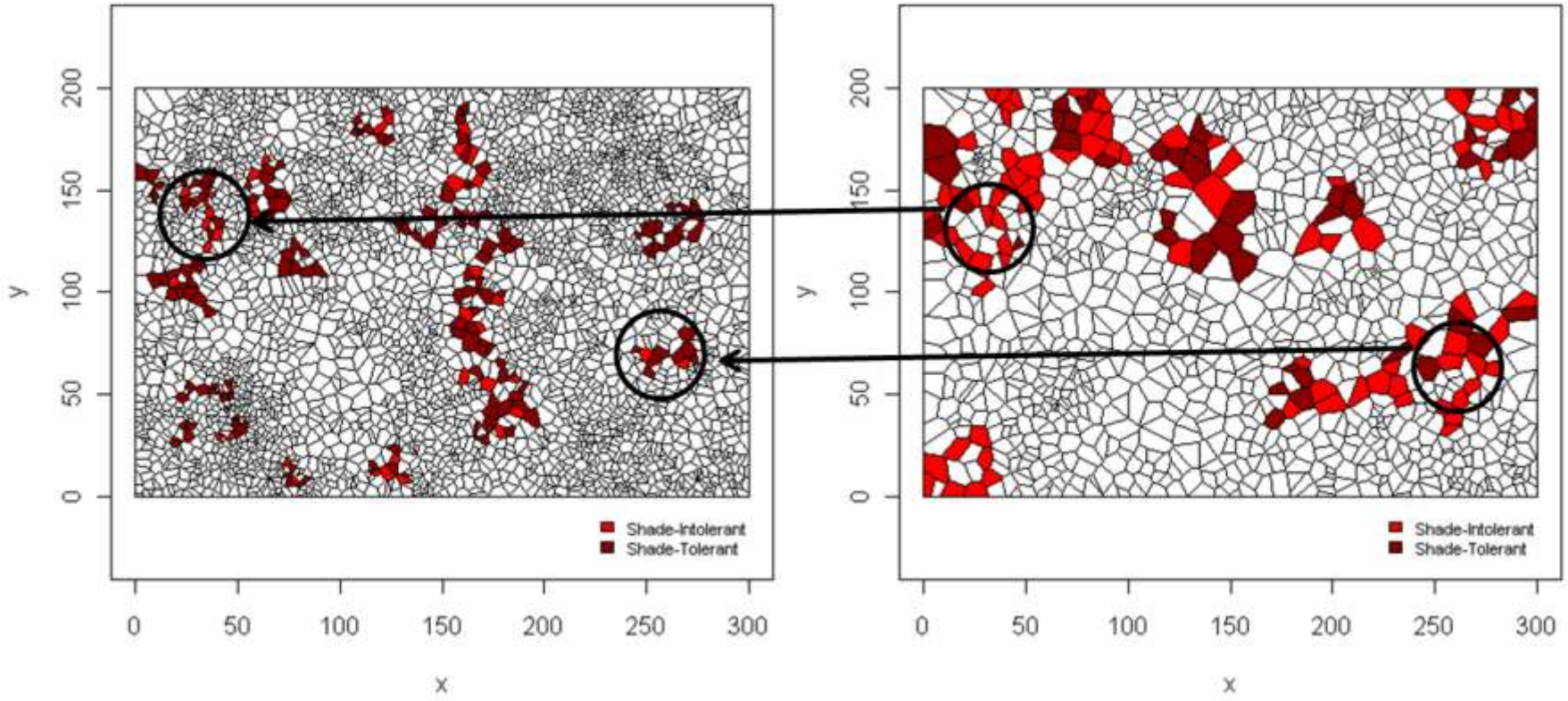
Comparing Patch : Canopy and Understory

- A part of overlapping gaps and Shade-Intolerant trees.
  - ➡ There were patch's Shade-Intolerant trees in gaps.
  - ➡ Shade-Intolerant trees grow up in sunlight area.



Comparing Patch : Canopy and Understory

- A part of overlapping Shade-Tolerant trees and Shade-Intolerant trees.
  - ➡ Shade-Intolerant trees don't have thick leave.
  - ➡ Shade-Intolerant trees of understory grow up under Shade-Intolerant trees of canopy.



Conclusion

- We developed patches detection methods using Echelon Dendrogram.
- Characteristics and heterogeneous characters of forest structure can be shown by using Echelon Dendrogram.
- We want to show a time series variation in the future.