



# Community Classification, Community Structure and Vegetation-Environmental Relationships of Forest Vegetation In South Korea

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Forest structure has significant influences on a series of structural and functional properties of forest ecosystems. However, there were few studies to classify Korean forests horizontally and vertically and to analyze the relationships between communities and environmental factors although their occurrence was highly correlated with ecological forest management. The purpose of this study is to develop forest management plan for forest vegetation of South Korea and to establish basic data for sustainable forest management. Data was used tree species of overstory vegetation of NFI and the importance value of tree species was calculated. environmental variables was measured and recorded in each stands. Importance value was also calculated for tree species of understory vegetation(DBH<6cm) in order to identify forest vertical structure and to predict potential natural vegetation. TWINSpan and CCA were conducted to identify communities and to analyze the relationships between communities and environmental variables. TWINSpan classified the different communities and the 16 communities were representative of the general forest vegetation in South Korea. CCA results revealed that altitude, slope, annual average temperature and precipitation were revealed as the environmental factors that most influenced distribution. Overall, the succession was proceeding in Korean forests. Especially, the understory vegetation of communities dominated by *Pinus densiflora*, *P. thunbergii* and *Chamaecyparis obtuse* which is distributed in the lowlands is dominated by the deciduous oak such as *Quercus serrata*. these communities will be replaced by the deciduous oak in the future. This study was supported by Mid-career Subsequent Researcher Program(NRF-2018R1A2B5A01021358) through NRF grant funded by the MEST.

## Introduction

The National Forest Inventory of Korea began with the 1st National Forest Survey, conducted from 1972 to 1974, followed by the 2nd (1978-1980), the 3rd (1986-1992), and the 4th (1996-2005), the 5th (2006-2010) and the 6th National Forest Inventory was conducted from 2011 to 2015. The purpose of this study is to provide basic data for establishing policy for sustainable forest management practices by securing basic statistics on inland forest resources and periodically identifying changes in the 6th National Forest Resources Survey data.

## Results

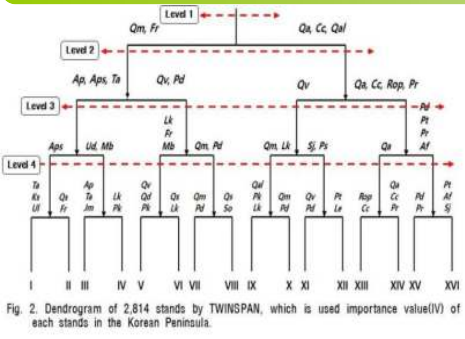


Table 2. Abbreviation of indicator species in study

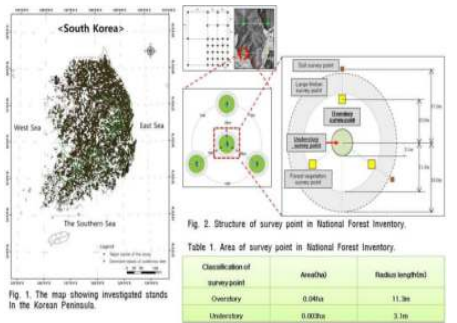
Abbreviation	Species
Am	<i>Alnus mandchurica</i>
Qm	<i>Quercus mongolica</i>
Fr	<i>Fraxinus mandchurica</i>
Pr	<i>Pinus koraiensis</i>
Ph	<i>Pinus thunbergii</i>
Qv	<i>Quercus variabilis</i>
Ph	<i>Phytolacca eschscholae</i>
Ud	<i>Ulmus lanceolatus</i>
Ud	<i>Ulmus davidsonii</i>
Aes	<i>Acer pseudo-sialkotianum</i>
Fr	<i>Fraxinus japonica</i>
Qs	<i>Quercus serrata</i>
Pr	<i>Pinus rigida</i>
Fr	<i>Fraxinus rhynchophylla</i>
Ca	<i>Castanea crenata</i>
La	<i>Lonicera erythrorhynchos</i>
Al	<i>Alnus firma</i>
Mh	<i>Morus bombycina</i>
Qs	<i>Quercus acuminata</i>
Pd	<i>Pinus densiflora</i>
Qm	<i>Quercus mongolica</i>
Rp	<i>Robinia pseudo-acacia</i>
La	<i>Lonicera erythrorhynchos</i>
Ph	<i>Pinus koraiensis</i>
Qs	<i>Quercus serrata</i>
Fr	<i>Fraxinus japonica</i>
Ta	<i>Tilia amurensis</i>

Table 3. Community name of groups which is classified by TWINSpan in the Korean Peninsula (Black bars mean deciduous forest and red lines mean coniferous forest. Conifers were excluded because they are not useful as wood in Korea)

Group division	Names of community classification
Group I	<i>Quercus mongolica-Tilia amurensis</i> community
Group II	<i>Quercus mongolica-Acer pseudo-sialkotianum</i> community
Group III	<i>Quercus mongolica-Fraxinus rhynchophylla</i> community
Group IV	<i>Quercus mongolica-Acer sargentii</i> community
Group V	<i>Quercus mongolica-Quercus variabilis</i> community
Group VI	<i>Lonicera erythrorhynchos-Quercus mongolica</i> community
Group VII	<i>Quercus mongolica-Pinus densiflora</i> community
Group VIII	<i>Quercus serrata-Quercus variabilis</i> community
Group IX	<i>Lonicera erythrorhynchos-Quercus variabilis</i> community
Group X	<i>Pinus densiflora-Quercus mongolica</i> community
Group XI	<i>Pinus densiflora-Quercus variabilis</i> community
Group XII	<i>Pinus densiflora-Quercus serrata</i> community
Group XIII	<i>Castanea crenata-Robinia pseudo-acacia</i> community
Group XIV	<i>Quercus acuminata-Pinus densiflora</i> community
Group XV	<i>Pinus densiflora-Pinus rigida</i> community
Group XVI	<i>Pinus thunbergii-Pinus densiflora</i> community

## Materials & Methods

### 1. Study area



### 2. Fieldwork and Data collection

Braun-Blanquet coverage value was estimated and recorded for each species in community layer of a stand. The investigated values were entered in an Excel spreadsheet(Microsoft Office 2007). And relativized which in turn were summed up to obtain importance value index(IV), relative coverage index(RCI, %), relative frequency index(RFi, %) and relative importance value index(RIV).

### 3. Multivariate methods

Two-way indicator species analysis(TWINSpan) was used to classify the plant community groups based on the overstory tree species, while canonical correspondence analysis(CCA) was used to investigate vegetation patterns and distributions of species with regard to their environmental variables, using PC-ORD5(MiM software Co). Environmental variables used for the CCA analysis were the altitude, slope, aspect, annual mean temperature(for about 35 years), canopy gap, initial growth period precipitation(from April to June), non-growth period precipitation(from November to March).

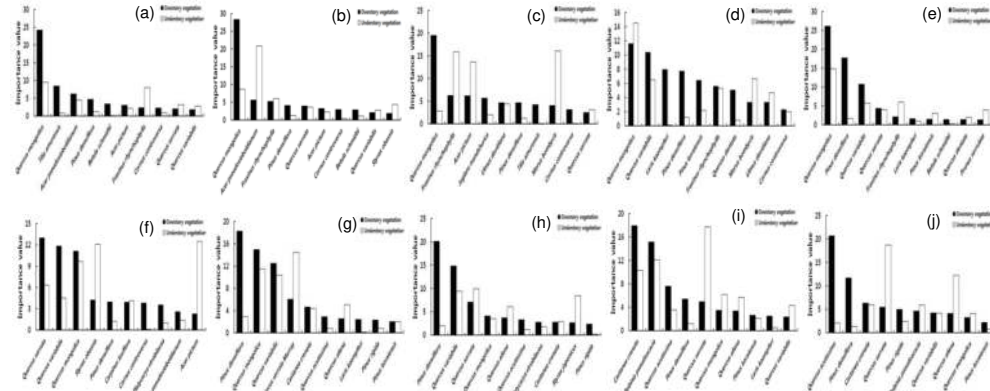


Fig. 3. Importance value(I) of major woody plant species of overstory(black bar), understory(white) of communities: a: *Quercus mongolica-Tilia amurensis* community, b: *Quercus mongolica-Acer pseudo-sialkotianum* community, c: *Quercus mongolica-Fraxinus rhynchophylla* community, d: *Quercus mongolica-Quercus variabilis* community, e: *Quercus mongolica-Pinus densiflora* community, f: *Quercus serrata-Quercus variabilis* community, g: *Pinus densiflora-Quercus mongolica* community, h: *Pinus densiflora-Quercus variabilis* community, i: *Castanea crenata-Robinia pseudo-acacia* community, j: *Quercus acutissima-Pinus densiflora* community).

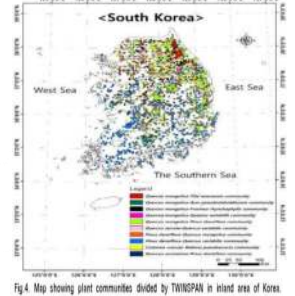


Fig. 4. Map showing plant communities divided by TWINSpan in inland area of Korea.

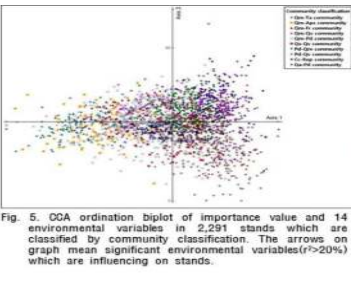


Fig. 5. CCA ordination biplot of importance value and 14 environmental variables in 2,291 stands which are classified by community classification. The arrows on graph mean significant environmental variables( $P > 20%$ ) which are influencing on stands.

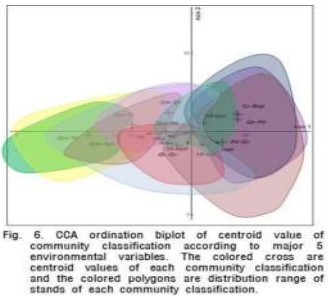


Fig. 6. CCA ordination biplot of centroid value of community classification according to major 5 environmental variables. The colored cross are centroid values of each community classification and the colored polygons are distribution range of stands of each community classification.

## Summary

- Two-way indicator species analysis(TWINSpan) of tree species resulted in sixteen ecologically distinct community types along different plant species variables.
- CCA results of grouped community reveal that five environmental variables, i.e. Altitude, Non-growth period precipitation, Initial growth period precipitation, Annual mean temperature, Slope, have a strong influence on distribution of stands and herb species. There was no change in number of leaf and specific leaf area according to global warming.
- The location environments of *Pinus densiflora-Castanea crenata* community, *Pinus densiflora-Pinus rigida* community, *Pinus thunbergii-Quercus serrata* community, *Castanea crenata-Robinia pseudo-acacia* community and *Quercus acutissima-Pinus densiflora* community which are lowland forest are similar and understory vegetation of the communities is dominated by *Quercus serrata*, so it will be changed by *Quercus serrata* forests.