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Ecological Relationships between Habitat Conditions, Plant Diversity and Geographic Location on the National Part, South Korea

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Abstract

In this paper, the relationships among forest vegetation and the environmental factors were studied from August 2012 to August 2014. The formation of habitat can be caused by non-native plant invasions, climate change or environmental conditions. However, the formation of ecosystem has remained a debated question. We tried to test a hypothesis in the special case of *Quercus mongolica, Quercus aliena, Carpinus laxiflora, Quercus serrata, Fraxinus rhynchophylla, Picea jezoensis, and Abies koreana* formatting natural habitat. We compared plant communities, soil properties, geological conditions and climatic conditions between plant species and mixed forests. Based on this, we make an ecological biogeography that shows the high elevation range limits of the species controlled by abiotic factors, such as climate and geography, while biogeography shows the determination by biotic interaction. Relationships among them were investigated using statistical analysis. These factors gave the effect of the formation of habitat. Especially, the climatic conditions and geographic locations were more important factors through the principle component analysis. We concluded that in formatting and managing forest ecosystems where natural habitats are mainly driven by mixture of major factors (i.e., climatic and geological conditions and soil characteristics).

Keywords: Abiotic factors, biotic factor, climate change, ecological biogeography, ecosystem, habitat, statistical analysis

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Introduction

Habitats have different populations at different sites (Warren 2010; Stanton-Geddes et al. 2012). The reasons could be that there are several factors that included soil properties, climatic and geological conditions. Also, the formatting habitats could be changed by the competition of indigenous and migrant plants (Stanton-Geddes et al. 2012). Meanwhile, the other study refers that the geological condition does not influence on the formatting natural habitats. The study of eastern hemlock (*Tsuga Canadensis*) in eastern Quebec from Kavanagh and Kellman (1986) and Stanton-Geddes et al. (2012) shows that the typical eastern hemlock is found more often on habitats with northern and western slope than eastern parts.

Firstly, climatic conditions play a key role in the habitat and distribution of the plants, in combination with other factors. Epecially, in the nature habitat and the climatic conditions are known to have had enormous impacts on the plant diversity pattern.

Secondly, geological conditions also play a key role in the habitat and distribution of plants which are spatial variables such as elevation and slope. Several specific tree and plant communities habit at different elevations and latitudes. The physiological requirements and tolerances of a species determine both its habit and its broader geographic distribution.

For soil characteristics, they are an important factor for formatting a habitat. Directly, nutrient levels, moisture contents and metal concentrations in soils support the natural habitats (Macnair 1987; Stanton-Geddes et al. 2012). These factors have a strong effect on plant growth and the formatting habitat (Sambatti and Rice 2006; Stanton-Geddes et al. 2012).

Hence, an understanding of the ecology should be approached through regional and local factors. The formatting habitats should be primarily controlled by abiotic factors, such as climate and geography, and biotic factors, such as soil characteristics, or biotic interactions (Stanton-Geddes et al. 2012). Five species, such as the *Quercus mongolica, Quercus aliena,Quercus serrata, Carpinus laxiflora, Fraxinus rhynchophylla , Picea jezoensis, and Abies koreana,* are distinguished in this study.

Quercus mongolica is native to the forested area in Japan amd it central and northern China and Korea. Specially, the native range of it covers through all the elevation its communities in the area is absolutely dominant in Korea. However, it is not known as characteristics of *Quercus mongolica* including ecological factors.

Quercus aliena communities are similar to *Quercus serrata* community as ecological aspect. *Quercus aliena* and *Quercus serrata* are appeared in the same area. Both of them are a mountain species in mountain area, Korea.

The Carpinus laxiflora has an important species as the climax in the temperate zone in Korea. In Korea, the *Quercus species* dominate on mountain in Korea. However, *Carpinus laxiflora* communities are classified with *Quercus aliena and Quercus mongolica* communities according to temperature and elevation.

Abies Koreana has been well known as a coniferous evergreen ad dwarf shrub. *A.Koreana* has been found in mountain areas with a high elevation zone. Recently, *A.Koreana* is being rapidly depleted due to habitat destruction and by climate change or human.

For the ecological analysis of the natural habitat, the spatial pattern analysis has been used to answer ecological question (Liehold and Gurevitch 2002). The analysis of the spatial pattern is performed using the observed data. These data can be expressed as most interesting ecological phenomena in space and time through a statistical analysis.

Generally, the statistical analysis is processed to deal specifically with spatial autocorrelation in ecological phenomena that vary with time. This process is to promote innovative investigations into the spatial dimension of population fluctuations. However, the autocorrelation analysis needs not be restricted to the same species but should be applied to populations of different species or even to completely independent, but potentially related, ecological phenomena through the cross correlation analysis. The correlation analysis can help to reveal the cause of variety of potentially interconnected ecological phenomena (Koenig 1999).

Several spatial interpolation techniques were used for mapping parameters, such as inverse distance functions, kriging and co-kriging (Kravchenko and Bullock 1999). Kriging techniques weighted from surrounding measured values to predicted values at unmeasured values. Spatial interpolation by co-kriging performed among the poorest interpolators due to the poor correlation between parameters (Hernandez-Stefanoni and Ponce-Hernandez 2006). Theoretically, the co-kriging was much more precise than the kriging, which includes estimating the autocorrelation for each variable as well as all cross-correlations.

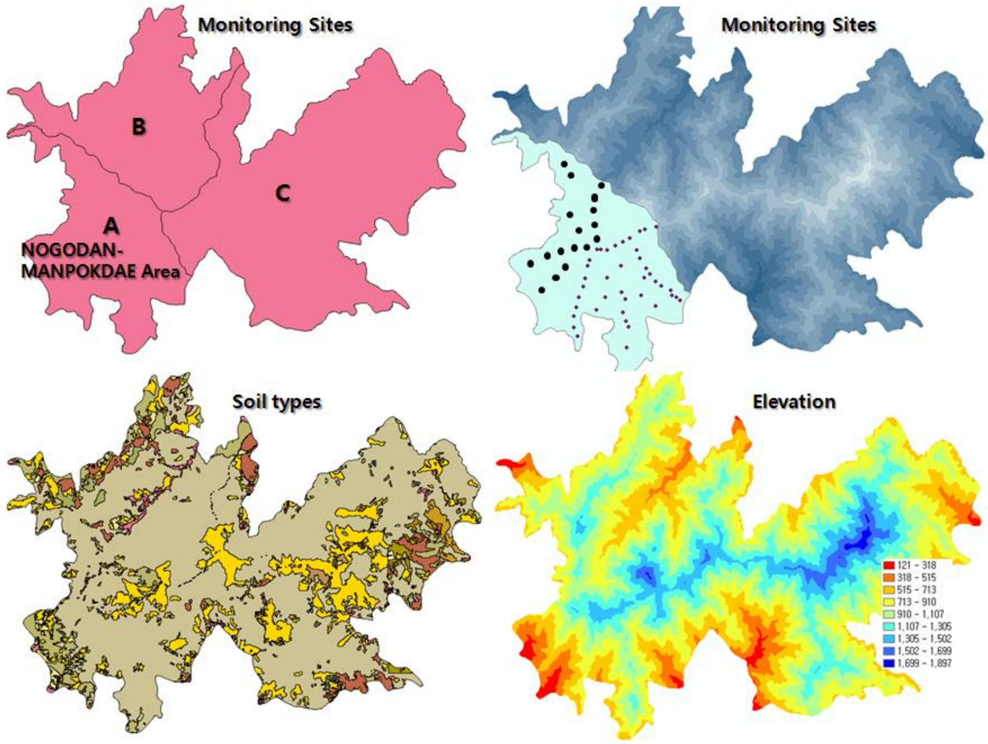
The purpose of this study is the cause of a variety of formations of natural habitat that should be revealed and the finding principal major factors can be applied to protect and manage the forest in mountain through monitoring and statistical analysis.

Materials and Methods

Study Area

This study was conducted in the West part of the Jirisan Mountain (1,915m, 35°20'11.58"N, 127°43'51.93"E) and it composed of three-sections (i.e., A, B, and C) called as NOGODAN-MANPOKDAE area in Korea (Figure 1). Especially, our research group was performed to focuse on section A (see Figure 1). Jirisan Mountain is one of the national parks and the inland alpine area in South-West Korea. It was a diverse flora because of it’s a relatively wide distribution of natural deciduous forest area (i.e., *Quercus mongolica, Quercus aliena Carpinus laxiflora*) even though thenatural coniferous forest area (i.e., *Abies koreana and Picea jezoensis*) exists at over 800 m (elevation). In terms of the vegetation in the Jirisan Mountain, Fagaceae (i.e., *Quercus* *mongolica*, *Quercus aliena*,*Quercus serrata*) are dominant. Over 800m elevation, *Taxus cuspidate* is partially dominant. The habitats of these flora form favorable soil conditions and weather conditions. A total of 14,200 ha was placed under the protection of the Korean Forest Service (KFS). Our study area was performed at section A (4,100 ha). The Korea Forest Research Institute has carried out comprehensive research regarding the influence of such forest management practices on the ecosystem (Korea Forest Research Institute, 2013).

Figure 1. *Study Area*



Sample Collection and Monitoring

Soil samples were collected from sixty habitats in Section A from the west part of Jirisan Mountain in 2014-2015. Samples were collected once every three month from all designed sixty sampling sites. The soil samples collected at a depth of about 10-20cm using hard trowel at each habitat (Boamponsem et al. 2010; Korangteng-Addo et al. 2011). The soil samples were kept in a polyethylene bags which had been rinsed and transported into the laboratory. Climatic data (2013-2014) were obtained from Korea Meteorological Admistration (KMA). The chemical parameters were analyzed to pH, EC, CEC, P_2O_5, TN, Ca^{2+}, Mg^{2+}, Na^{2+}, K^+, and OM (APHA 1995). The elevation data was obtained when the sampling and monitoring data was collected in the field. Table 1 shows the number of the sites monitored.

Table 1. *Number of Sites Monitored*

Plant species	No. of sites monitored	Classify
Quercus mongolica	10	1
Quercus serrata	10	2
Quercus aliena+Quercus serrata+Q.dentata	15	3
Fraxinus rhynchophylla+Carpinus laxiflora+etc	15	4
Abies Koreana	3	5
Picea jezoensis	5	6
Abies koreana	2	7

etc*: Cornus controversa HEMSL; Acer palmatum Thunb; Pinus densiflora;*

Statistical Analysis

We performed a correlation analysis to determine the possible relationship among climatic, soil characteristic and soil chemical parameters for plant community formation, using the SPSS V.12 K software (SPSS Inc., USA). Also, since our data was not normally distributed, a nonparametric Spearman rank correlation was performed to compare relevant parameters (Lee et al. 2010). In addition, factor an analysis was applied to reduce the number of variables. The correlation matrix was formatted first. Based on the scree plot, which graphs the eigenvalue against the factor number, the extracted components (0.4>) were rotated using varimax rotation, after choosing one of the orthogonal rotations (Lee et al. 2009). The rotated factor loading generated the rotated factor matrixes which represents the correlation between the variable and the factors (Lee et al. 2009). Each correlation value was in the range -1 to +1; however, results with correlations of 0.3 or less are not presented in this study (Lee et al. 2009).

Between 2014 and 2015, 7 species were ecologically and statistically investigated in the Jirisan National Park (sector A). The chemical parameters are used as pH, EC, CEC, P_2O_5, TN, Ca^{2+}, Mg^{2+}, Na^{2+}, K^+, and OM. Climatic and geological parameters are rainfall data and elevation. For mapping the parameters, the kriging technique was applied over the studied area (sector A). For this study, the cross-semivariogram was used to quantify the cross-spatial auto-covariance between the original variable and the covariate. The cross-semivariance was computed through the equation:

$$\gamma_{12}(h) = \frac{1}{2n}\sum_{i=1}^{n}[Z_1(x_i+h) - Z_1(x_i)][Z_2(x_i+h) - Z_2(x_i)] \quad (1)$$

Parameter estimates were obtained using co-kriging computed from the following expression:

$$Z(x_o) = \sum_{i=1}^{n}\lambda_{1i}Z_1(x_i) + \sum_{j=1}^{m}\lambda_{2j}Z_2(x_j) \quad (2)$$

Where λ1j and λ2j were the optimal weights selected to minimize the estimation variance (Hunner 2000; Hernandez-stefanoni and Ponce-Hernandez 2006). Cokriging in the multivariate situation are used for simple and ordinary cokriging (Goovaerts 1998). Moreover, the cokriging system for estimating the local primary and secondary means implicitly used in simple cokriging is established (Goovaerts 1998). Let $\{Z_1(\mu_{\alpha 1}), \alpha_1 = 1,....,n_1)$ be the values of the primary attribute Z_1 at n1 location $\mu_{\alpha 1}$. To alleviate the notation considering the situation where there is only one secondary attribute Z_2 measured at, a possibly different, location $\mu_{\alpha 2}, \{Z_2(\mu_{\alpha 2}), \alpha_2 = 1,....,n_2)$. The simple cokriging (SCK) estimator of Z_1 at a location of μ is written:

$$Z_{SCK}^{(1)*}(\mu) - m_1 = \sum_{\alpha 1}^{n1(\mu)} \lambda_{\alpha 1}^{SCK}(\mu)\left[Z_1(\mu_{\alpha 1}) - m_1\right] + \sum_{\alpha 2}^{n2(\mu)} \lambda_{\alpha 2}^{SCK}(\mu)\left[Z_2(\mu_{\alpha 2}) - m_2\right] \quad (3)$$

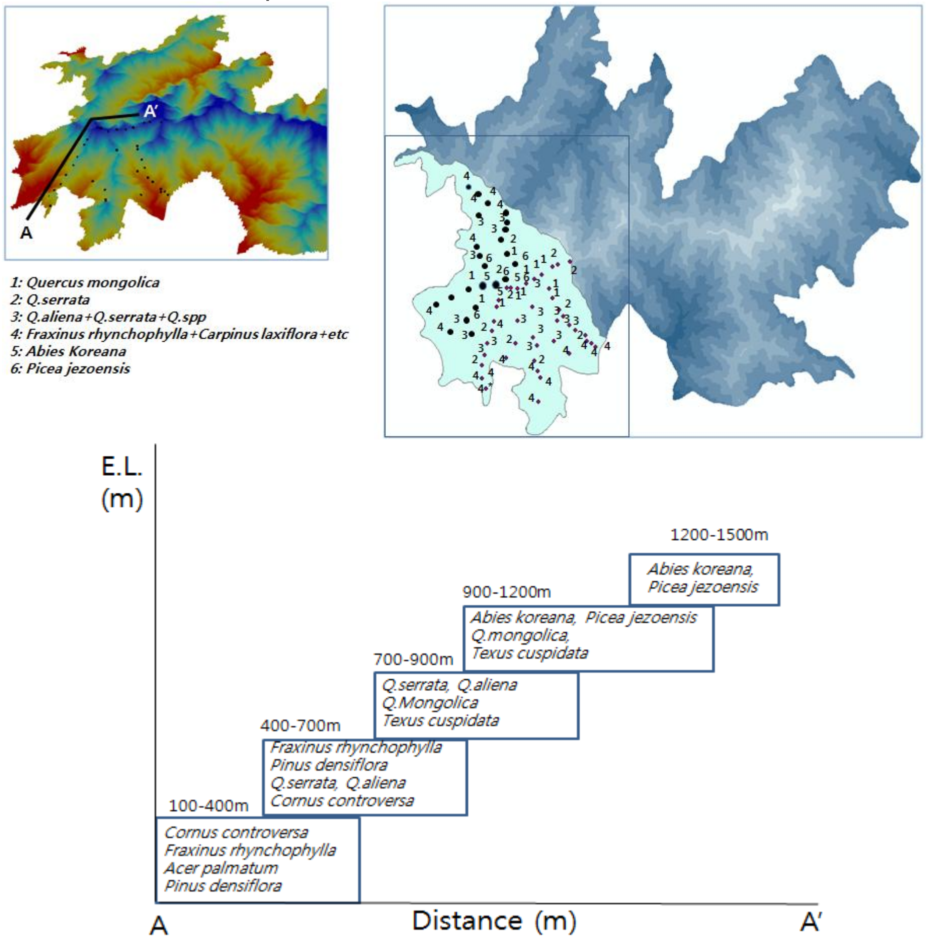
Where $\lambda_{\alpha 1}^{SCK}(\mu)$ is the weight assigned to the primary datum $Z_1(\mu_{\alpha 1})$, $\lambda_{\alpha 2}^{SCK}(\mu)$ is the weight assigned to the secondary datum $Z_2(\mu_{\alpha 2})$, and m_1 and m_2 are the primary and secondary means assumed as known and constant within the study area.

Results and Discussion

Distribution of Plant Comunity

The sector A had diverse flora habitats such as *Quercus mongolica, Quercus aliena, Cornus controversa HEMSL; Acer palmatum Thunb; Pinus densiflora, Carpinus laxiflora, Abies koreana and Picea jezoensis.* Their habitats showed a delicate difference according to climatic condition, geological and soil conditions. Figure 2 showed a distribution of the plant habitats in sector A. Figure 2 showed a distribution of the plant habitats according to A (EL. 100m)-A'(EL.1,500m). At the EL of 100-900m, the distribution of the plant habitats was relatively diverse. The major habitat types were as follows: *Pinus densiflora, Acer palmatum, Fraxinus rhychophylla, Cornus controversa, Quercus serrata,* and *Q. aliena*. Also, their habitats were relatively mixed. At the EL of 900-1500m, the major habitat types were *Abies koreana, Picea jezoensis, Quercus mongolica, and Texus cuspidate.*

Figure 2. *Distribution of Plant Habitats*



Abies koreana and Picea jezoensis

Abies koreana and *Picea jezoensis* were mainly formatted above EL 900 m. The summary of statistical data in *Abies koreana* and *Picea jezoensis* habitats were followed as 1114 m for EL, 12.9℃ for temperature, 5.2 for pH, 26.8 mg/L for P_2O_5, 0.4 % for TN, and 15.3% for organic matter at May and June. Table 2 showed the correlation coefficient matrix among the parameters in the habitats of *Abies koreana and Picea jezoensis*. Three components were extracted through the total variance explained and the scree graph. Also, the rotated component matrix and the component plot were obtained from varimax rotation for the PCA extraction method. The results are shown in Table 3.

Table 2. *Correlation Coefficient for Abies koreana and Picea jezoensis (p>0.05)*

	EL	Temp	pH	EC	CEC	P_2O_5	TN	Ca^2	Mg^2	Na^2	K	OM
EL	1.0											
Temp	-1.0	1.0										
pH	0.5	-0.4	1.0									
EC	-0.3	0.3	-0.7	1.0								
CEC	-0.7	0.7	-0.3	0.1	1.0							
P_2O_5	0.3	-0.3	-0.1	0.4	-0.2	1.0						
TN	-0.3	0.3	0.1	0.1	0.3	0.4	1.0					
Ca^2	0.5	-0.5	0.2	-0.2	0.3	0.1	-0.1	1.0				
Mg^2	-0.6	0.6	-0.1	0.1	0.3	-0.3	0.4	-0.5	1.0			
Na^2	-0.2	0.2	0.3	-0.2	0.4	-0.4	0.5	0.3	0.4	1.0		
K	0.1	-0.1	0.1	0.0	0.4	0.2	0.2	0.8	-0.4	0.5	1.0	
OM	-0.1	0.1	-0.5	0.3	0.5	0.4	0.0	0.5	-0.4	-0.3	0.5	1.0

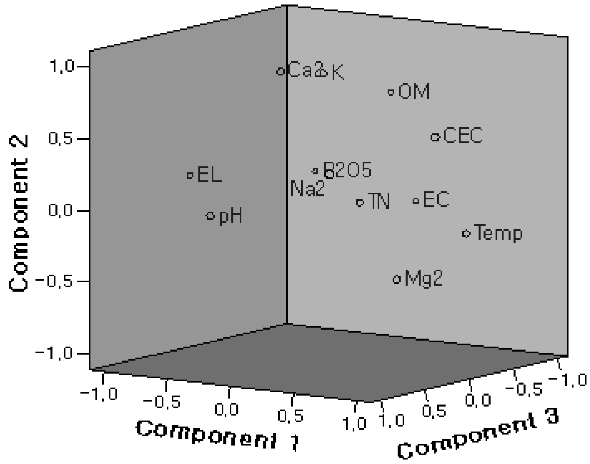
Therefore, the principal component equations (Y) for *Abies koreana* and *Picea jezoensis* were followed as equation (4);

$$Y_1 = -0.9EL + 0.9Temp + 0.8pH + 0.7EC + 0.5Na^2 - 0.5OM$$
$$Y_2 = 0.5pH - 0.4EC + 0.9CEC + 0.9P_2O_5 + 0.7TN \qquad (4)$$
$$Y_3 = -0.7TN + 0.8Ca^{2+} - 0.8Mg^{2+} + 0.7Na^{2+} - 0.5OM$$

This means that the habitat condition 1 (Y_1) mainly depended on EL, Temperature, pH, EC, Na^{2+}, and organic matter. Also, the major components were pH, EC, CEC, P_2O_5 and TN for Y_2 and TN, Ca^{2+}, Mg^{2+}, Na^{2+}, and organic matter for Y_3.

Table 3. *Rotated Component Matrix and Component Plot for Abies koreana and Picea jezoensis*

	1	2	3
EL	-0.9		
Temp	0.9		
pH	0.8	0.5	
EC	0.7	-0.4	
CEC		0.9	
P_2O_5		0.9	
TN		0.7	-0.7
Ca^2			0.8
Mg^2			-0.8
Na^2	0.5		0.7
K			
OM	-0.5		-0.5



Extraction method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Quercus mongolica and Texus cuspidate

Quercus mongolica and *Texus cuspidate* were mainly formatted above EL 700 m. The summary of statistical data in *Quercus mongolica* and *Texus cuspidate* habitats were followed as 811 m for EL, 4.9 for pH, 15.1℃ for temperature, 82.7 mg/L for P_2O_5, 16 % for TN, and 20.4% for organic matter. Table 4 showed the correlation coefficient matrix among the parameters in the habitats of *Quercus mongolica and Texus cuspidate*. Three components were extracted through the total variance explained and the scree graph. Also, the rotated component matrix and component plot were obtained from the varimax rotation for the PCA extraction method. The result are shown in Table 4.

Table 4. *Correlation Coeffient for Quercus mongolica and Texus cuspidate*

	EL	Temp	pH	EC	CEC	P_2O_5	TN	Ca^2	Mg^2	Na^2	K	OM
EL	1.0											
Temp	-0.7	1.0										
pH	0.7	-0.4	1.0									
EC	-0.6	0.8	-0.5	1.0								
CEC	-0.3	0.0	-0.5	0.2	1.0							
P_2O_5	-0.6	0.4	-0.7	0.4	0.5	1.0						
TN	0.2	-0.8	0.1	-0.6	-0.1	-0.3	1.0					
Ca^2	-0.2	0.3	0.0	0.2	0.3	0.4	-0.3	1.0				
Mg^2	-0.3	0.1	-0.7	0.4	0.6	0.6	0.0	-0.1	1.0			
Na^2	-0.1	0.0	-0.5	0.0	0.2	0.4	-0.2	-0.1	0.1	1.0		
K	-0.1	0.4	-0.4	0.5	0.2	0.2	-0.4	-0.1	0.4	0.4	1.0	
OM	-0.7	0.5	-0.2	0.4	0.1	0.2	-0.3	0.2	-0.1	-0.1	-0.3	1.0

Therefore, the principal component equations (Y) for *Quercus mongolica* and *Texus cuspidate* were followed as equation (5);

$$Y_1 = -0.8EL + 0.8Temp - 0.8pH + 0.8EC + 0.8CEC - 0.5P_2O_5 + 0.5TN + 0.4Ca^{2+} + 0.6Mg^{2+} + 0.5Na^2$$

$$Y_2 = -0.5CEC + 0.59P_2O_5 + 0.5TN + 0.4Ca^{2+} + 0.6Mg^{2+}$$

$$Y_3 = 0.5P_2O_5 + 0.4Ca^{2+} - 0.7Na^{2+}$$

This means that the habitat condition 1 (Y_1) mainly depended on EL, Temperature, pH, EC, CEC, P_2O_5 ,TN, Ca^{2+}, Mg^{2+}, and Na^{2+}. Also, the major components were CEC, P_2O_5, Ca^{2+}, Mg^{2+}, and TN for Y_2 and P_2O_5,Ca^{2+}, and Na^{2+} for Y_3.

Quercus spp., Pinus densiflora, Fraxinus rhynchophylla, and Cornus controvesa

Quercus spp., Pinus densiflora, Fraxinus rhynchophylla, and Cornus controvesa were mainly formatted above EL 400 m. The summary of the statistical data in their habitats were followed as 488 m for EL, 4.5 for pH, 17.3℃ for temperature, 113.9 mg/L for P_2O_5, 23 % for TN, and 17.1% for the organic matter. Table 5 showed the correlation coefficient matrix among the parameters in the habitats of *Quercus spp., Pinus densiflora, Fraxinus rhynchophylla, and Cornus controvesa*. Three components were extracted through a total variance explained and the scree graph. Also, the rotated component matrix and component plot were obtained from the varimax rotation for the PCA extraction method. The results are shown in Table 6.

Table 5. *Correlation Coeffient for Quercus spp., Pinus densiflora, Fraxinus rhynchophylla, and Cornus controvesa*

	EL	Temp	pH	EC	CEC	P_2O_5	TN	Ca^2	Mg^2	Na^2	K	OM
EL	1.0	-1.0	0.5	-0.3	0.1	-0.8	0.1	-0.5	0.3	-0.3	-0.5	-0.4
Temp	-1.0	1.0	-0.4	0.3	-0.2	0.7	0.0	0.4	-0.5	0.3	0.4	0.4
pH	0.5	-0.4	1.0	-0.1	0.0	-0.3	0.5	-0.4	0.0	0.2	-0.2	0.3
EC	-0.3	0.3	-0.1	1.0	-0.3	0.2	-0.2	0.1	0.0	0.0	0.2	0.3
CEC	0.1	-0.2	0.0	-0.3	1.0	0.0	-0.7	0.0	0.6	0.0	0.4	-0.4
P_2O_5	-0.8	0.7	-0.3	0.2	0.0	1.0	-0.2	0.4	0.0	0.6	0.3	0.2
TN	0.1	0.0	0.5	-0.2	-0.7	-0.2	1.0	-0.2	-0.6	0.0	-0.4	0.5
Ca^2	-0.5	0.4	-0.4	0.1	0.0	0.4	-0.2	1.0	0.2	0.0	0.8	0.0
Mg^2	0.3	-0.5	0.0	0.0	0.6	0.0	-0.6	0.2	1.0	0.1	0.5	-0.3
Na^2	-0.3	0.3	0.2	0.0	0.0	0.6	0.0	0.0	0.1	1.0	0.1	0.6
K	-0.5	0.4	-0.2	0.2	0.4	0.3	-0.4	0.8	0.5	0.1	1.0	0.0
OM	-0.4	0.4	0.3	0.3	-0.4	0.2	0.5	0.0	-0.3	0.6	0.0	1.0

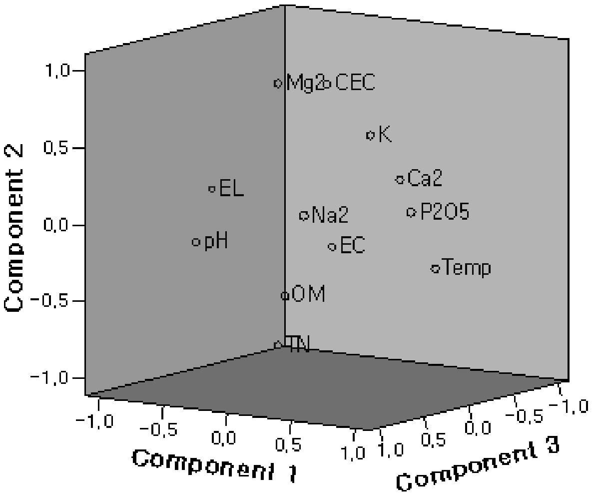
Therefore, the principal component equations (Y) for *Quercus spp., Pinus densiflora, Fraxinus rhynchophylla, and Cornus controvesa* were followed as equation (6);

$$Y_1 = -EL + 0.9Temp - 0.8pH + 0.7EC + 0.6CEC - 0.5K$$
$$Y_2 = 0.5CEC - 0.8P_2O_5 + 0.8TN + 0.8Ca^{2+} - 0.6Mg^{2+} - 0.4OM \quad (6)$$
$$Y_3 = +0.4Ca^{2+} + 0.5Mg^{2+} + 0.8Na^{2+} + K$$

This means that the habitat condition 1 (Y_1) mainly depended on EL, Temperature, pH, EC, CEC, and K^+. Also, the major components were CEC, P_2O_5, TN,Ca^{2+}, Mg^{2+}, and OM for Y_2 and Ca^{2+}, Mg^{2+}, K and Na^{2+} for Y_3.

Table 6. *Rotated Component Matrix and Component Plot for Quercus spp., Pinus densiflora, Fraxinus rhynchophylla, and Cornus controvesa*

	1	2	3
EL	-1.0		
Temp	0.9		
pH	0.8		
EC	0.7		
CEC	0.6	0.5	
P_2O_5		-0.8	
TN		0.8	
Ca^2		0.8	0.4
Mg^2		-0.6	0.5
Na^2			0.8
K	-0.5		0.6
OM		0.4	



Extraction method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Conclusions

This study provides the relationship among the environmental parameters and the formation of the natural habitats through the statistical analysis. The species distribution should be caused by regional climate and edaphic conditions such as the climatic parameter (temperature), geological parameter (elevation and slope) and soil chemical characteristics. The ecological statistical analysis is used for identifying and describing the reason of formatting the plant community. The understanding of Formatting plant community is followed by a complex process. In case of *Abies koreana* and *Picea jezoensis*, temperature, elevation, pH, EC, and organic matter were major factors for formatting the habitat through PCA (see equation (4)). In general, these species live in high land areas, of over 900 m. Also, *Abies koreana* and *Picea jezoensis* can be analyzed as the soil chemical parameters (see equation (4)).

Table 7. *Comparison of Parameters to Y_1 for PCA*

Y_1	EL	Temp	pH	EC	CEC	P_2O_5	TN	Ca^2	Mg^2	Na^2	K	OM
A. koreana, P. jezoensis												
Q. mongolica, T. cuspidate												
Q.spp., P. densiflora, F. rhynchophylla, C. controvesa												

In the case of *Quercus mongolica and Texus cuspidate*, temperature, elevation, pH, EC, CEC, P_2O_5, TN, and inorganic ions were major factors for formatting habitat through PCA (see equation (5)). Also, the statistical analysis showed that the ecological characteristics of other species (i.e., *Quercus spp., Pinus densiflora, Fraxinus rhynchophylla, and Cornus controvesa*) were similar to *Abies koreana*, *Picea jezoensis*, *Quercus mongolica* and *Texus cuspidate*. Notably, the important difference was shown as Table 7. In the jirisan mountain elevation, EC and temperature were key factors in all the regions. Meanwhile, organic matter in the habitat of *A. koreana* and *P.jezoensis* was an important factor comparing to other habitats.

In further study, our authors will perform monitoring and analysis for precision result to the jirisan national park, South Korea.

References

American Public Health Association (APHA) (1995) Standard methods for the examination of water and wastewater. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 19th edition, Washington, D.C.

Boamponsem LK, Adam JI, Dampare SB, Nyarko BJB, Essumang DK (2010) Assessment of atmospheric heavy metal deposition in the Tarkwa gold mining area of Ghana using epiphytic lichens. Nucl Inst Met Phy Res. 268: 1492-1501.

Goovaert P (1997) Geostatistics for natural resources evaluation. Applied geostatistics series. Oxford University Press, London.

Hernandez-Stefanoni JL, Ponce-Hernandez R (2006) Mapping the spatial variability of plant diversity in a tropical forest:Comparison of spatial interpolation methods. Env Mon Ass. 117: 307-334. DOI= 10.1007/s10661-006-0885

Hunner G (2000) Modeling forest stand structure using geostatistics, geographic information systems, and remote sensing. Ph.D. Disseration. Colorado State University. pp 217.

Lee JY, Yang J-S, Han MY, Choi JY (2010) Comparison of the microbiological and chemical characterization of harvested rainwater and reservoir water as

alternative water resources. Sci Tot Environ. 408: 896-905. DOI=10.1016/j.scitotenv.2009.11.001.
Liehold AM, Gurevitch J (2002) Integrating the statistical analysis of spatial data in ecology. Ecogra. 25:553-557. DOI=10.1034/j.1600-0587.2002.250505.x
Kavanagh K, Kellman M (1986) Performance of Tsuga Canadensis Carr. At the centre and northem edge of its range: a comparison. *J Biogeogr*. 13:145-157. DOI= 10.1111/j.0014-3820.2006.tb01149.x.
Koenig WD (1999) Spatial autocorrelation of ecological phenomena. *TREE*. 14 (1); 44-58.
Koranteng-ADDO EJ, Bentum JK, Awuah B, Owusu-Ansah E (2011) Analysis of Cu and Pb in the sediments of Kakum River, its estuary and tributaries. Int.J.Biol.Chem.Sci. 5:111-122.
Korea Forest Research Institute (2013) Korea weather condition in the eastern part of Korea. Hydrology J. 1: 213-215
Kravchenko A, Bullock D (1999) A Comparative Study of Interpolation Methods for Mapping Soil Properties. Agronomy J. 91: 393-400. DOI= 10.2134/agronj1999.00021962009100030007x.
Macnair M (1987) Heavy metal tolerance in plants: A model evolutionary system. Trends Ecol Evol. 2:354-359.
Sambatti J, Rice KJ (2006) Local adaptation, patterns of selection, and gene flow in the Californian serpentine sunflower (*Helianthus exilis*), Evolution. 60:696-710.
Stanton-Geddes J, Shaw RG, Triffin P (2012) Interactions between Soil Habitat and Geographic Range Location Affect Plant Fitness. PLoS One. 7(5):101-115 DOI=10.1371/journal.pone.0036015.
Warren RJ (2010) An experimental test of well-described vegetation patterns across slope aspects using woodland help transplants and manipulated abiotic drivers. New Phytol. 185:1038-1049. DOI= 10.1111/j.1469-8137.2009.03147.x