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# Regional Level Impact of Global Warming on the Distribution of Oak Stands in Central Korea

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## Introduction

Natural distribution of tree species can be affected by site factors such as topography, soil, climate etc. It has been increasingly recognised that global warming can impact also on the natural distribution of tree species. To find the mechanism of how the global warming impacts on the natural distribution of tree species, two kinds of approaches can be applied. One is the global level approach based on the different climate conditions and the other is regional level approach based on the same climate condition. In the regional level, the climate change can actually affect the natural distribution of the tree species through the micro-climate change which is affected by the topographical factors. In this study, focusing on regional level approach, we tried to first find the relationship between oak's spatial distribution and topographical characteristics. And the ultimate objective of this study is to find how to influence the global warming on the temperature change and spatial distribution of oak species in regional level forests.

## Methods and Materials

In this study, spatial characteristics of tree species distribution was analyzed using high resolution satellite imagery and geo-morphological factors based on GIS.

The spatial distribution of Quercus spp.(Q. mongolica, Q. variabilis, Q. acutissima) in a natural deciduous forest was classified using IKONOS satellite imagery taken in May 2000 with 4m spatial resolution and 4 spectral band.

Raster thematic maps of elevation, slope, and exposition were prepared using Digital Elevation Model (DEM) taken using digital contour map of 1:5,000 scale. Geo-temperature index and aspect index of each raster cell were calculated from the DEM and corresponding raster thematic maps were also prepared.

Finally, the occupation probability model was prepared as a function of the variables of the geo-morphological factors such as geo-temperature index and aspect index (Fig. 1). From the occupation probability model, the spatial distribution of the oak species can be predicted with the given temperature change.

## Results and Discussions

### 1. Current spatial distribution of tree species

Tree species were classified and the current spatial distribution map of oak species were prepared (Fig. 2).

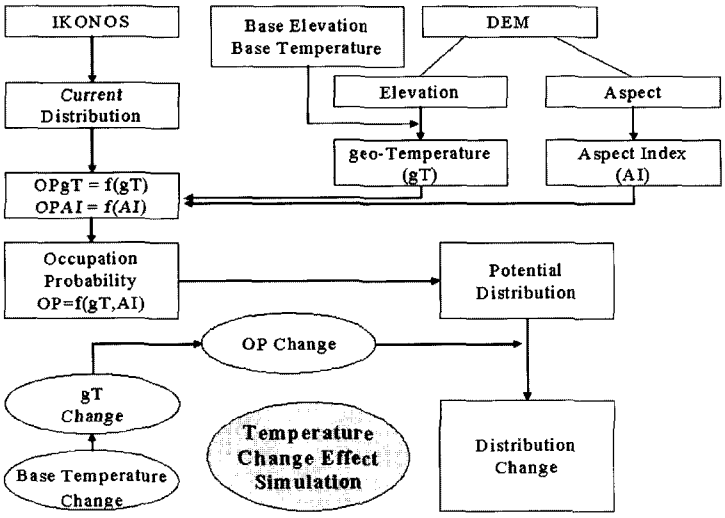


Fig. 1. Process for classification of current forest type distribution, and prediction of spatial potential distribution of forest type

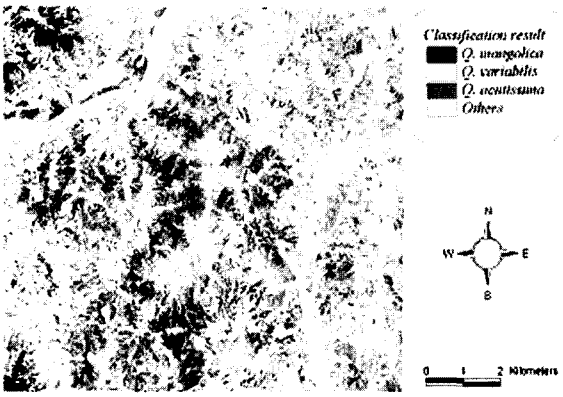


Fig. 2. Current spatial distribution of forest type

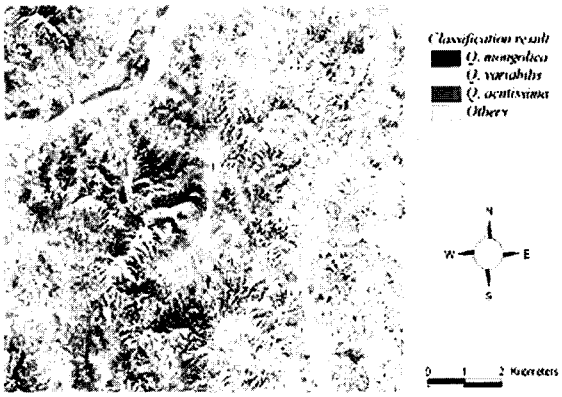


Fig. 3. Potential spatial distribution of forest type bability model.

Table 1: Estimated parameters of occupation probability equations with geo-Temperature index (gT)

| Tree Species | Estimated Parameters[1] | | | R2 | Equation[2] |
|---|---|---|---|---|---|
| | a | b | c | | |
| *Q. mongolica* | 11.936 | 2.015089043 | 2.652608922 | 0.94 | Weibull |
| Q. variabilis | 277.1563158 | -0.4771504 | | 0.95 | Exponential |
| Q. acutissima | 0.9323197 | 34.00614399 | 2.43081261 | 0.96 | Logistic |

1) All parameters are significant at a significance level of 0.0001

2) Weibull equation : $OPgT = \frac{c}{b}\left(\frac{gT-a}{b}\right) e^{-\left(\frac{gT-a}{b}\right)^c}$

Exponential equation : $OPgT = a \cdot e^{b \cdot gT}$

Logistic equation : $OPgT = \frac{a}{1+e^{b-c \cdot gT}}$

Table 2. Estimated parameters of occupation probability equations[2] with aspect index (AI)

| Tree Species | Estimated Parameters[1] | | | | | R2 |
|---|---|---|---|---|---|---|
| | a | b | c | d | e | |
| Q. mongolica | -0.7077596 | 0.3938795 | -0.3903660 | 0.1672703 | 0.3006684 | 0.96 |
| Q. variabilis | 0.0346577 | -0.0379536 | -0.1574615 | 0.1447133 | 0.3552685 | 0.95 |
| Q. acutissima | 0.0736650 | -0.3557967 | 0.5476421 | 0.3118988 | 0.3440591 | 0.96 |

1) All parameters are significant at a significance level of 0.0001
2) 4th polynomial equation : $QPAI=aAI^4+bAI^3+cAI^2+dAI+e$

Table 3. Transition matrix of the oak species with the increasing temperature

+ 0.25℃

| | *Q.mongolica* | *Q.variabilis* | *Q.acuticima* | sum |
|---|---|---|---|---|
| *Q.mongolica* | 0.77 | 0.01 | 0.22 | 1.00 |
| *Q.variabilis* | 0.12 | 0.67 | 0.21 | 1.00 |
| *Q.acuticima* | 0.00 | 0.00 | 1.00 | 1.00 |

+0.5℃

| | *Q.mongolica* | *Q.variabilis* | *Q.acuticima* | sum |
|---|---|---|---|---|
| *Q.mongolica* | 0.55 | 0.00 | 0.45 | 1.00 |
| *Q.variabilis* | 0.18 | 0.43 | 0.39 | 1.00 |
| *Q.acuticima* | 0.00 | 0.00 | 1.00 | 1.00 |

+1.0℃

| | *Q.mongolica* | *Q.variabilis* | *Q.acuticima* | sum |
|---|---|---|---|---|
| *Q.mongolica* | 0.22 | 0.00 | 0.78 | 1.00 |
| *Q.variabilis* | 0.12 | 0.12 | 0.76 | 1.00 |
| *Q.acuticima* | 0.00 | 0.00 | 1.00 | 1.00 |

## 2. Occupation probability model with geo-Temperature index (gT)

Occupation probability models with the variables of geo-Temperature index(gT) were prepared for each oak species (Table 1).

## 3. Occupation probability model with aspect index (AI)

Occupation probability models with the variables of aspect index (AI) were prepared for each oak species(Table 2).

## 4. Potential spatial distribution of tree species

Fig. 3 shows the potential spatial distribution of oak species which were predicted by the occupation probability model.

## 5. Spatial distribution change with the temperature change

The spatial distribution change of the oak species could be simulated with the increasing temperature (Fig. 4).

With increasing temperature, the stands of Q. mongolica and Q. variabilis tend to be changed to

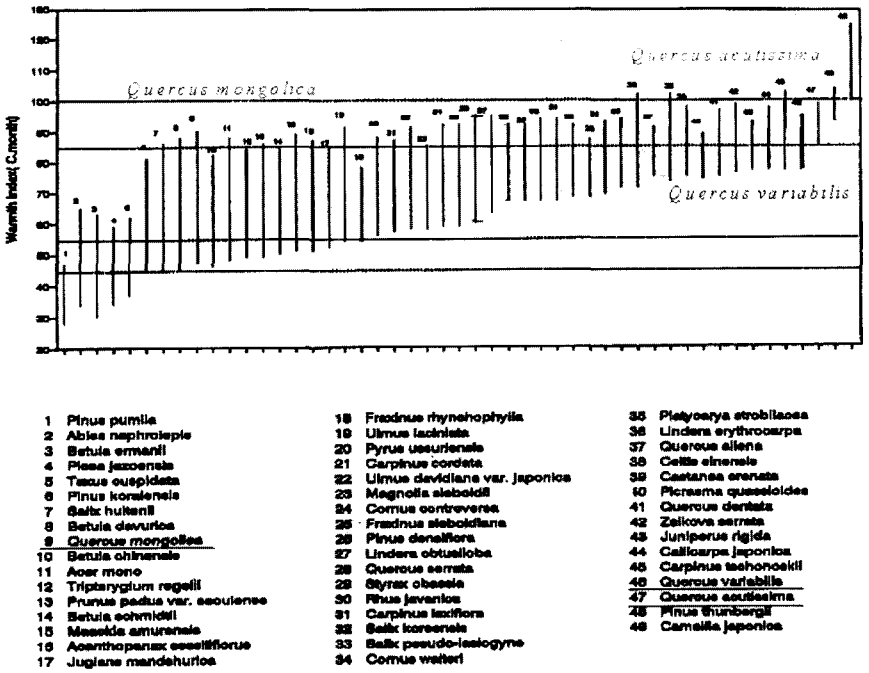


Fig. 5. Warmth index range for the growth of tree species

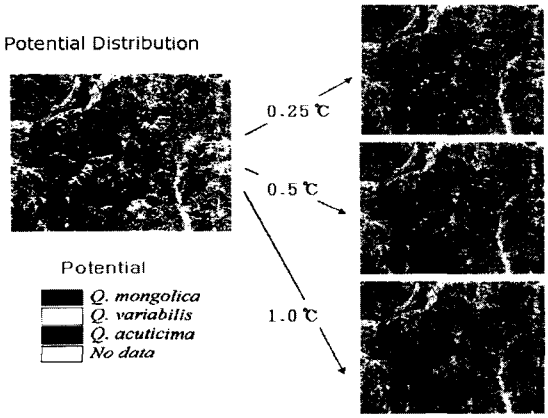


Fig. 4. Spatial distribution change with the temperature change

the stand of the Q. acutissima. which grows in the higher range of warmth index (Fig. 5) comparing the other two oak species(Table 3).

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