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Spatial Density Estimates of Plant Biodiversity in KhokHin Lad National Forest, Thailand

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ABSTRACT: The plant species in the KhokHin Lad national forest, MahaSarakham, Thailand is the important for the community nearly the area. The objectives of this paper to (1) study of the plant biodiversity using the species diversity indexes (2) the estimation of spatial density of plant biodiversity using the spatial interpolation techniques. The species indexes for analysis of plant species was the relative density (RD), relative domination (RDo), relative frequency (RF), importance value index (IVI), and Shannon-Weiner index. The interpolated techniques were use the Inverse Distance Weighted (IDW) and kriging methods. The results show that the most of plant species base on the IVI were Shoreaobtusa Wall. ex Blume(17.60 %), Xyliaxylocarpa (17.40%), and Dipterocarpus punctulatus Pierre (12.88%), respectively.The species diversity index of the field surveyed sample plot by Shannon-Wiener Index was 2.35.

KEYWORDS: Shannon-Wiener Index, importance value index (IVI), Inverse Distance Weighted (IDW), kriging methods.

I. INTRODUCTION

Plant density represented simply the number of plants exiting per unit area of ground. Plan density is the important factors for explain production in the area, although a number of species can compensate for low plant density by comparatively significant development of individual plants during the growth cycle [1]. The plant density indicator not only depends on the area in which it can grow. It is also determined by the quantity of resources available. Especially in the case of light, smaller plants will use fewer resources than larger plants. This is even less than expected due to size differences. As the density of plants increases, it affects the structure of the plant as well as the development pattern of the plant [2].

Thailand is located in a humid climate that supports a wide range of tropical ecosystems. Unlike tropical ecosystems, tropical ecosystems provide a wide compartment for the survival of living organisms, and as such, they can support a wide variety of flora, animals and microorganisms. Thailand has about 15,000 species of plants, accounting for 8% of all plant species found worldwide [3]. MahaSarakham province is located in the northeastern region of Thailand. The province is mostly a plain covered with rice fields. The total forest area is 213.76 sq.km. or 3.8 percent of provincial area [4]. MahaSarakham province has tropical monsoon weather and the average temperature ranges from 26.9 - 28.2 degrees Celsius. The average annual rainfall is about 1,300 millimeters. KhokHin Lad national forest in MahaSarakham province of Thailand is the original large forest which has a size of tens of thousands of acres and has different types of plants. The forest area, as announced by the ministerial regulations in the past, has an area of 6 sq.km.

Spatial interpolation is the process of using known points to estimate values at other unknown points. For instance, to make a map of rainfall for the country, the data of rainfall will not find enough even distribution weather stations to cover the region. Spatial interpolation can estimate the rainfall at the locations without recording data using known rainfall at the near weather station. The kind of interpolates map is often called a spatial statistical such as elevation data, rainfall data, snow accumulation, water tables, and population density are other types of data that can be calculated using spatial interpolation [5]. Spatial interpolation methods divide into two categories are deterministic

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and statistical (geostatistical) interpolation methods. Inverse distance weighting (IDW) is one of the most used widely in the estimation of spatial rainfall. The IDW method computes that the estimated unknown value points using the spatial distance of values at the known points. Kriging is the most commonly used geostatistical method for spatial interpolation. Kriging method relies on a spatial estimate model between the known point from observations to predict the unknown value at the unsampled point. The kriging method computes that the distance between known sampled points reflects the spatial correlation that can be used to explain the variation of the difference in the surface.

In this paper focused base on the estimate of the plant mapping of plat biodiversity in KhokHinLad national forest, MahaSarakham province, Thailand.

II. MATERIALS AND METHODS

Study area

The KhokHin Lad national forest the located cover three district of MahaSarakham province include: Muaeng, Kae Dam, and Wapi Pathum district. The study are lies between 16.03º to 16.32º N Latitude and 103.16º to 103.20º E Longitude shown in Figure 1. The most of forest type in MahaSarakham is deciduous dipterocarp forest (DDF). The DDF is found in dry area, soil is acidic, shallow, sandy, and lateritic. The characteristics is open canopy and abundance of grasses and herbs. The trees of the DDF are deciduous and leaves in the dry season.

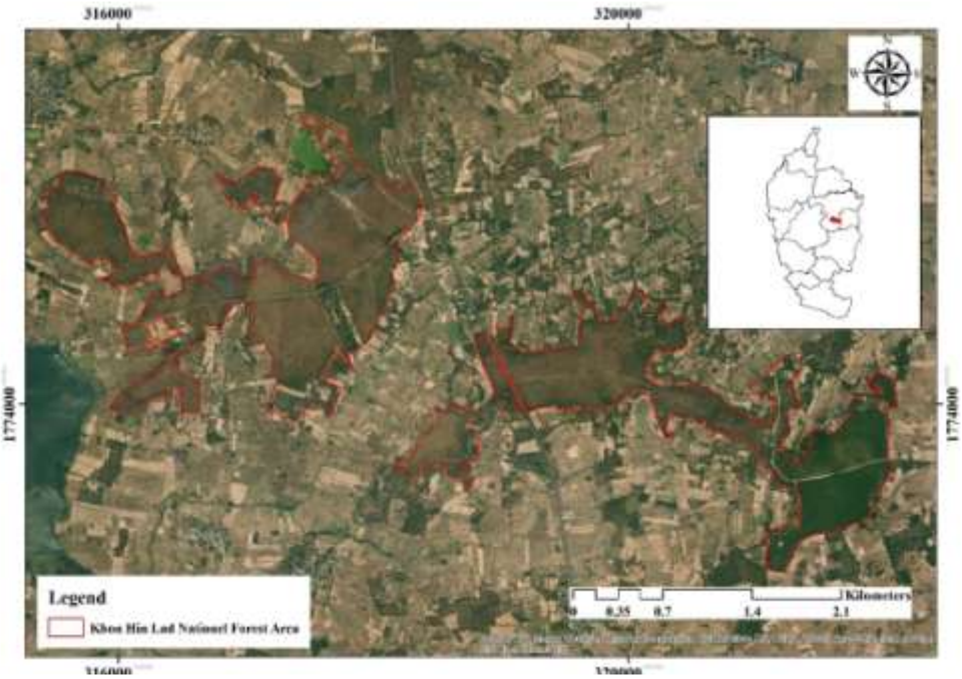

Figure 1. The location of the study area

Data collection and analysis the biodiversity of plants

Planning for observation of plant biodiversity in the study area used the sampling plot was the enumeration of randomly sample plots using the stratified random method [6]. The total of sampling plot was 47 plots by each plot has a dimension of 40 m. × 40 m. Data collection was conducted to all tree plant with the height of trees greater than 120 cm found in the observation plots. The attribute of data collection was record include: name species, name of trees, number, height, and diameter. The parameter for definition of the biodiversity indexes using the Shannon-Weiner index methods [7]. The parameter for analysis of important of the plant species by using the relative density (RD), relative domination (RDo), relative frequency (RF), and importance value index (IVI) [8,9].

The Shannon-Weiner indexwas developed from information theory and relies on measuring uncertainty. The degree of uncertainty in predicting the species of random sample is relative to the diversity of the community.The Shannon-Wiener index for a plant community is derived using the following equation [10]:

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$$H = -\sum_{i=1}^{S} (p_i)(\ln p_i)$$

Where
H= index of species diversity
S = number of species
p_i = proportion of total sample belonging to the ith species
ln = natural log[1]

The Shannon-Wiener Index the high value is given to the presence of each species thanis given to the abundance of each species.

Spatial interpolation of plant estimate mapping

Spatial interpolation predicts the value of a cell in raster form a limited number of sample data points. It can be used to predict unknown values for geographical point data such as altitude, rainfall, chemical concentration, volume, etc [10].Spatial Interpolationmethod including trend surface models, thiessen polygons,kernel density estimation, inverse distance weighted (IDW), splines, and kriging. The basic input of spatial interpolation requires two inputs are sample points and · spatial interpolation method. In this paper were use IDW and kriging methods for conduct of spatial plant density mapping as following:

Spatial interpolation using Inverse Distance Weighting (IDW)

Inverse Distance Weighted (IDW) is a method of interpolation that estimates cell values by averaging the values of sample data points in the neighborhood of each processing cell. The closer a point is to the center of the cell being estimated, the more influence, or weight, it has in the averaging process. This method assumes that the variable being mapped decreases in influence with distance from its sampled location [9]. The IDW assumes that the similarity of values of a spatially distributed numerical variable z decreases with distance d or a power p of the distance. This decline of similarity is incorporated in the interpolation as

$$\hat{z}(s_0) = \frac{\sum_{i=1}^{n} \frac{z(s_i)}{d_i^p}}{\sum_{i=1}^{n} \frac{1}{d_i^p}}$$

where
s_0 : indicates the location to be interpolated to, s_i (i = 1,…, n) indicates the n location
z : has been observed
d_i : the distance between x_0 and x_i.

The main factor that affects IDW accuracy is the value of power parameter. Weights diminish as the distance increases, especially when the value of the power parameter increases, so nearby samples have a heavier weight and have more influence on the estimation, and the resultant spatial interpolation is local [11,12].

Spatial interpolation using kriging

Kriging is similar to IDW in that it weights the surrounding measured values to derive a prediction for an unmeasured location. The general formula for both interpolators is formed as a weighted sum of the data:

$$\hat{Z}(s_0) = \sum_{i=1}^{N} \lambda_i Z(s_i)$$

Where
$Z(s_i)$: the measured value at the ith location
λ_i:an unknown weight for the measured value at the ith location
s_0 : the prediction location
N = the number of measured values

In IDW, the weight, λi, depends on the distance to the prediction unknown point. However, the kriging method, the weights are does not depend on the distance between the measured points and the prediction location but also the overall spatial arrangement of the measuring points. To use spatial arrangements in weights, the spatial correlations must be quantified. The weight λi depends on a fitted model to the measured points in the ordinary kriging. The distance between the known points to predicted unknown point and spatial relationship with the measured values around the predictive of unknown point [10].

Proposes Methods

This paper proposed the methods to estimate of plant biodiversity density mapping using IDW and kriging methods of geoinformatics, the step following: surveying for data collection with the 47 sampling plots. The data was calculating for analyzed of for analysis of important of the plant species indexes are RD, RDo, RF, and IVI values. The plant biodiversity map was conduct from the RD values of the sampling plots by using the IDW and kriging methods. The proposed of this paper shown in Figure 2.

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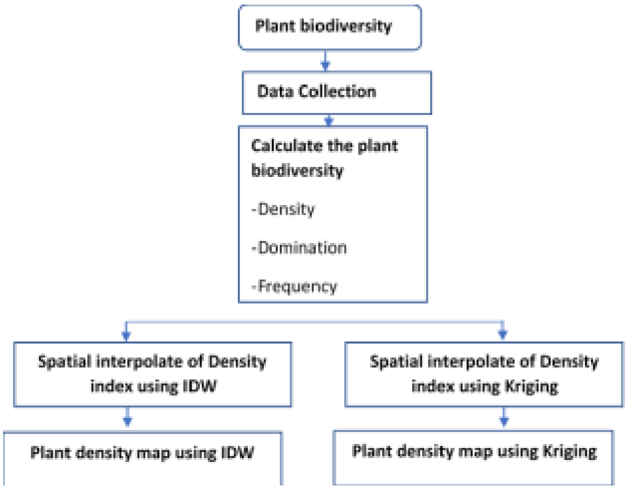

Figure 2. Propose methods

III. RESULTS

The results of plant biodiversity

The results of the data collected from the field surveyed sample plot with 47 plots found that the total number of 2556 trees.The results revealed that the diversity of tree were 57 species. The most of ten rank from the dominance species base on the IVI wereShoreaobtusa Wall. ex Blume(17.60 %), Xyliaxylocarpa (17.40%), Dipterocarpus punctulatus Pierre (12.88%), Shoreasiamensis(9.26%), Dipterocarpus tuberculatusRoxb. (7.69%), CanariumsubulatumGuillaumin (6.07%), ErythrophleumsuccirubrumGagnep. (3.66%), BuchananialatifoliaRoxb. (3.47%), Lanneacoromandelica (Houtt.) Merr. (2.01%), and Sindorasiamensis (1.80%) respectively.The lowest value of IVI was Canthiumcoromandelicum (0.10%), Dolichandronespathacea Schum (0.10%), and Acacia auriculiformis (0.10%), respectively. The species diversity index of the field surveyed sample plot by Shannon-Wiener Index was 2.35.

The results of the relative density (RD) refer to the numerical strength of the plant species in relation to the total numberof individuals of all the plant species. The high the RD values of five rank values wereShoreaobtusa Wall. ex Blume (22.79), Xyliaxylocarpa (22.69), Dipterocarpus punctulatus Pierre (14.63), Shoreasiamensis(10.95), and Dipterocarpus tuberculatusRoxb. (7.31), respectively. The lowest RD values were Canthiumcoromandelicum (0.03), Dolichandronespathacea Schum (0.03), and Acacia auriculiformis(0.03), respectively.

The results of spatial interpolation of plant biodiversity density estimate mapping

The result of spatial plant biodiversity density estimated map to interpolate the unknown of the RD value were estimated as unknowns and RD values from the surveyed using IDW. IDW relies primarily on the inverse of mathematically power raiseddistance. The power parameter allows to control the significance of known points on the interpolated values based on their distance from the output point. It is a positive, real number, and its default value is 2. The result of spatial interpolation estimated of the plant biodiversity density map of IDW method as shown in Figure 3.

The result of spatial plant biodiversity density estimated map to interpolate the unknown of the RD value were estimated as unknowns and RD values from the surveyed using kriging method. The optional output variance of the estimated unknown RD prediction contains the kriging variance. Assumed the kriging errors are normally distributed, there is a 95.5 percent probability that the actual z-value at the cell is the predicted unknown value, plus or minus two times the square root of the value in the variance unknown value.The result of spatial interpolation estimated of the plant biodiversity density map of the kriging method as shown in Figure 4.

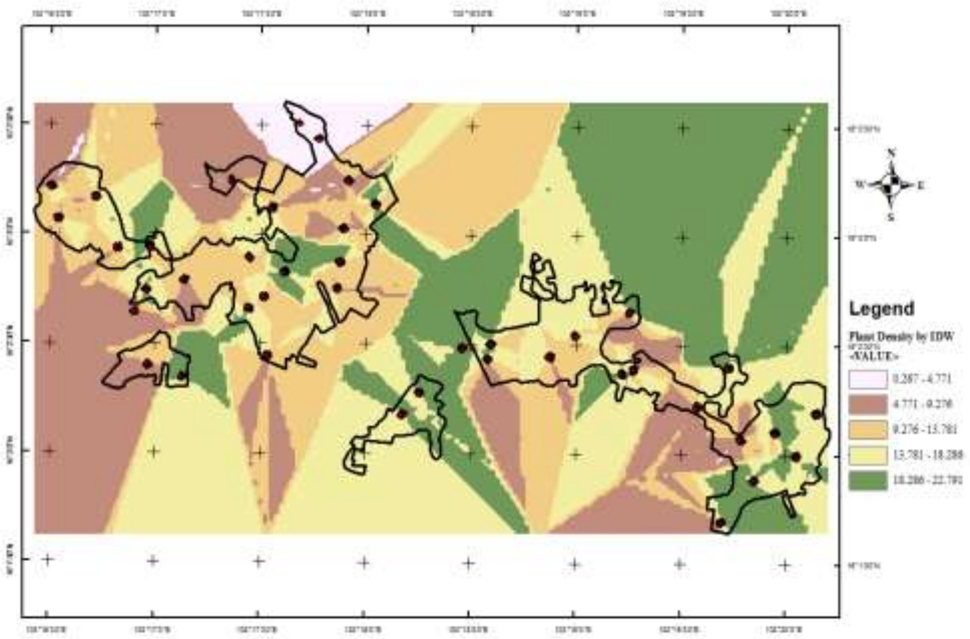

Figure 3. Map of spatial plant biodiversity density using IDW method

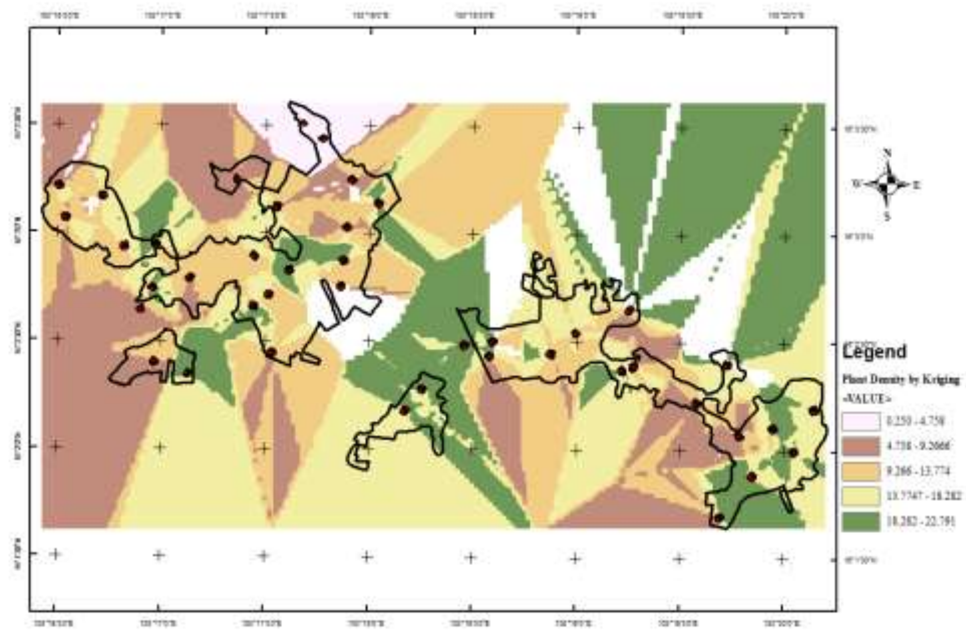

Figure 4. Map of spatial plant biodiversity density using kriging method

IV. CONCLUSION

The results of the observation in the KhokHin Lad natinal forest park in MahaSarakham province, Thailand the indicates show that Shoreaobtusa Wall. ex Blumehad highest of IVI and RD value were 17.60 % and 22.79, respectively. The lowest value of IVI and RD values show thatCanthiumcoromandelicum, Dolichandronespathacea Schum and Acacia auriculiformiswere 0.10 % and 0.03, respectively. The species diversity index of the field surveyed sample plot by Shannon-Wiener Index was 2.35. The Shannon-Wiener Index which showed that the plant species in the study area wasthe variety of tree species, their distribution and the of the dominance.

The results of the spatial interpolation show that the highest of RD value was 22.791 and lowest value was 025, respectively. The visual interpolation for the both map show that the distribution of the plant density in the study area their distribution similarly.

V. ACKNOWLEDGMENT

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