Isarithm Mapping of Pandemic Covid-19 Significant Area with Kriging Surface and Semi-Variance Analysis.

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ABSTRACT

Isarithm mapping shows statistical data aggregated over predefined regions. Pandemic Covid-19 situations can be represented as isarithm maps, depending on interpolation surface techniques. Kriging is the probabilistic interpolation surface that estimates semi-variance between pairs of data points over a range of distances. This study indicates a variance map of Thailand Covid-19 spreading, which gives any measure of uncertainty in the interpolated values and also being the example of estimation map for the pandemic significant area. Absolutely results are described.

Keywords: Isarithm mapping, Cocid-19, Probabilistic interpolation, Semi-variance

1. INTRODUCTION

Currently, the world is in a situation of the covid-19 epidemic. Thailand, which is an important country in Southeast Asia was greatly affected by this epidemic disease. In the field of geospatial and cartography, we can present this epidemic in several ways. As an explorer and cartographer, therefore, I have applied the isarithm map method to be used with the geographic information program. To be intended as an epidemiological statistical surface mapping model. Those interested in the spatial analysis have brought this practice to further use.

In this study, the data of covid-19 infected people of the Department of Disease Control were used for analysis. This information is available online that the general public can download. However, because this isarithm thematic mapping involves a lot of fundamental statistical concepts, some interested students or researchers, which didn't have any good statistical background, should pay attention to study more from books or academic documents on statistics. To be integrated with the technique of using software GIS for mapping. It will be very useful.

2. MAIN CONCEPTS

2.1 Geostatistical Modelling

- Kriging

Kriging is a stochastic method for spatial interpolation. Based on the regionalized variable theory, kriging assumes that the spatial variation of an attribute such as changes in grade within an orebody or elevations of the land surface is neither totally random nor deterministic. Instead, the spatial variation may consist of three components: a spatially correlated component, representing the variation of the regionalized variable; a 'drift' or structure, representing a trend; and a random error term (Oliver and Webster, 1990).

- Semivarience and Semivariogram

Semivarience is the geostatistical method to express the degree of relationship between points on a surface. The semivariance is simply half the variance of the differences between all possible points spaced a constant distance apart. The semivariance at a distance d = 0 should be zero because there are no differences between points that are compared to themselves. However, as points are compared to increasingly distant points, the semivariance increases. If there is strong spatial dependence, points that are closer together will have a smaller semivariance (Hartmann. et al, 2018).

$$\text{Semivariance} = \frac{1}{n} \times \sum_{r_t < \text{Average}}^{n} (\text{Average} - r_t)^2$$

where:

n = The total number of observations below the mean

r_t =The observed value

Average = The mean or target value of the dataset

The semivariogram is a plot of semivariance as a function of the distance between the observations and is the source of information used in kriging to achieve optimal weighting functions for mapping. Kriging uses the semivariogram, or rather a mathematical model of the semivariogram, in calculating estimates of the surface at the grid nodes.

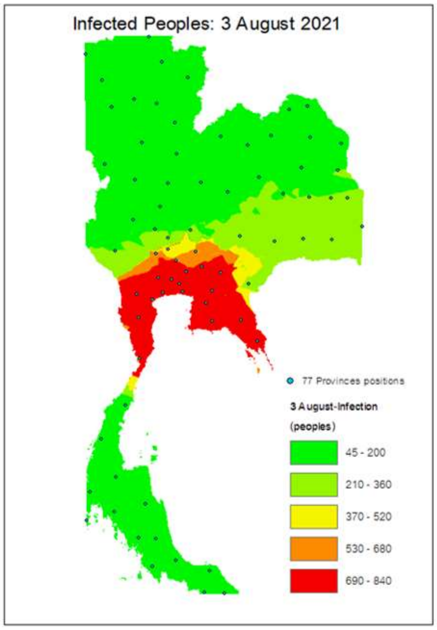
Semivariogram(distance h) = 0.5 * average [(value at location i– value at location j)2]

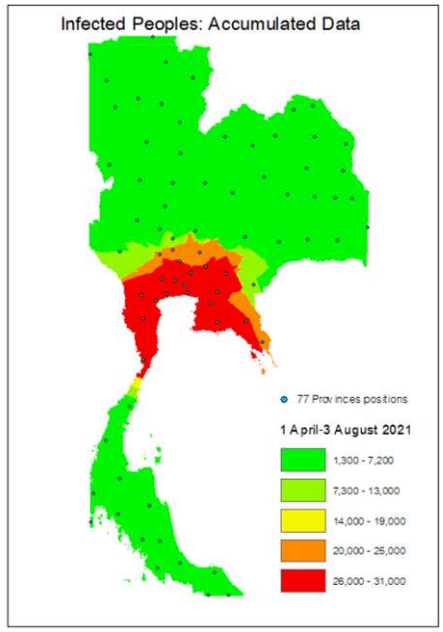
2.2 Isarithm map

Isarithm map uses isolines to depict continuous values like precipitation levels. These maps can also display three-dimensional values like elevation on topographic maps. Generally, data for isarithmic maps are gathered via measurable points. It must be feasible to consider the mapped phenomena continuous; discrete phenomena cannot be mapped isarithmically (Robinson et. al., 1995, and Dent, B. D., et, al, 2009).

Various advantages to the isarithmic technique must be weighed in the selection process:

1. Isarithmic mapping shows the total distribution of a spatially varying phenomenon.
2. It is flexible and can easily be adapted to a variety of levels of generalization or degrees of precision.
3. The technique is easily rendered by using computerized cartographic methods.





a) b)

Figure 1. a and b., COVID-19 Infected peoples of THAILAND.

3. RELATED DATA AND METHODS

3.1 Thai Covid-19 Pandemic data

This study used data on people infected with the coronavirus pandemic from all 77 provinces of Thailand. Such information is from the Department of Disease Control. There are two types of data: 1) daily infection data on 3 August 2021 and 2) cumulative infected data (1 April – 3 August 2021). Some related information as being shown in Table 1.

Table 1. Some related Covid 19 information.

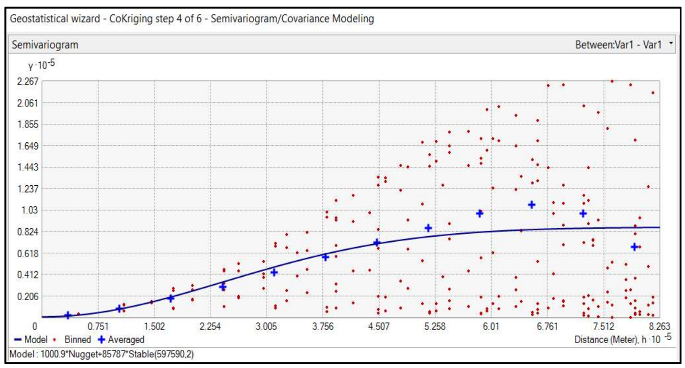
Provinces	3 August 2021 (peoples)	Accumulated 1 April – 3 August 2021 (peoples)
Bangkok	3566	161731
Samutprakarn	1361	41919
Chonburi	1359	29127
Samutsakorn	1282	34301
Nonthaburi	565	25989
Pathumthani	465	20840
Nakornratchasima	454	6201
Ubolratchatani	448	5868
Burirum	405	4507
Srakaew	382	3365
Srisaket	358	4943
Suphanburi	218	4838

3.2 Geostatistical method with GIS

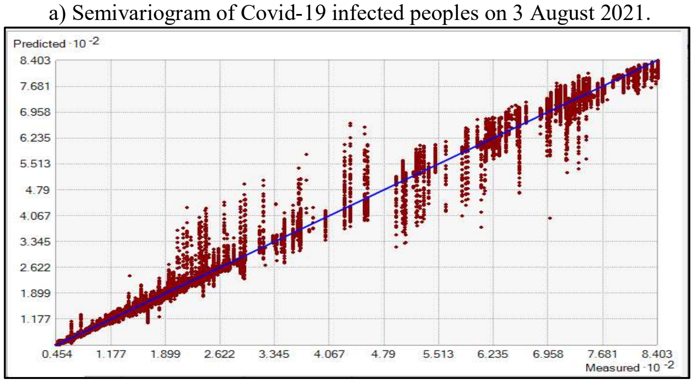
I calculate covid-19 pandemic information base on geostatistical main concepts as to be represented in section 2.1 with ArcGIS software. I found any different views of data analysis results. As to be shown in fig. 1 a and b, represent the kriging surface of infected peoples of all 77 provinces of Thailand.

3.2.1 ***Semivariogram of Ordinary Co-Kriging Methods: 3 Aug 2021***.

In statistic concept, "Group together data is bins". The counts of detections have been binned logarithmically, within mass bins covering factors. For Semivariogram result, all bins are red color dots. Average points are shown as blue crosses and are generated by binning empirical semivariogram/covariance points that fall within angular sectors. Binned points show local variation in the semivariogram/covariance values, whereas average values show smooth semivariogram/covariance value variation (figure 2a).



a) Semivariogram of Covid-19 infected peoples on 3 August 2021.



b) Cross-validation of Covid-19 infected peoples on 3 August 2021.

Figure 2. Semivariogram&Cross-validation of Covid-19 infected peoples on 3 August 2021.

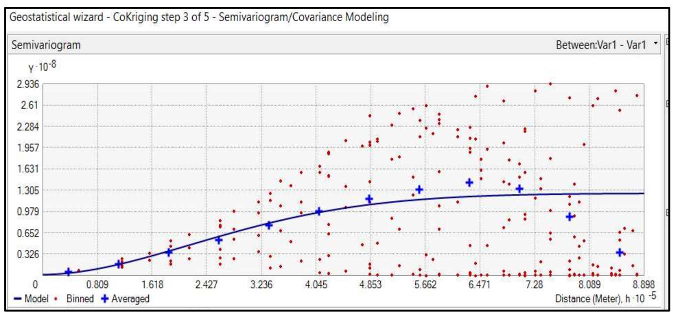
This semivariogram comes from an ordinary kriging surface which interpolated from 77 province location points, also all points have their own infected covid-19 pandemic data. The range is the distance where the model first flattens out is nearly around $6.01(10^{-5})$, and the sill is mean the value on the y-axis that the semivariogram model attains at the range, is nearly around $0.824(10^{-5})$. The nugget is the semivariogram model intercepts the y-axis, as being around 0.001.

For cross-validation results, the root means the square error is 11.32, which means so much variate from stable, although, the calculation of Root Mean Square Standardized Error is 0.349, less than 1, this means we overestimate all variabilities of our prediction (figure 2b).

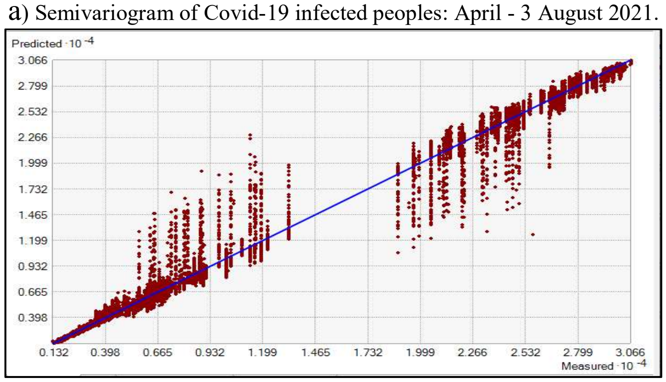
3.2.2 *Semivariogram of Ordinary Co-Kriging Methods*: *Accumulated Data.*

From section 3.2.1 we have considered semivariogram of covid 19 infected peoples with co-kriging method from daily infected data. For this topic, we will use cumulative infected data from April 2021 to August 3, 2021, to create a semivariogram. to consider the outcome.

From figure 3a, the range is around 7.28 (10^{-5}). The sill was found as nearly 0.98(10^{-8}), and the nugget was very close to 0.01. For cross-validation results (figure 3b), the calculation of Root Mean Square Standardized Error is 0.395, less than 1, and this value is very close to the root mean square error of co-kriging method of daily infected peoples of section 3.2.1



a) Semivariogram of Covid-19 infected peoples: April - 3 August 2021.

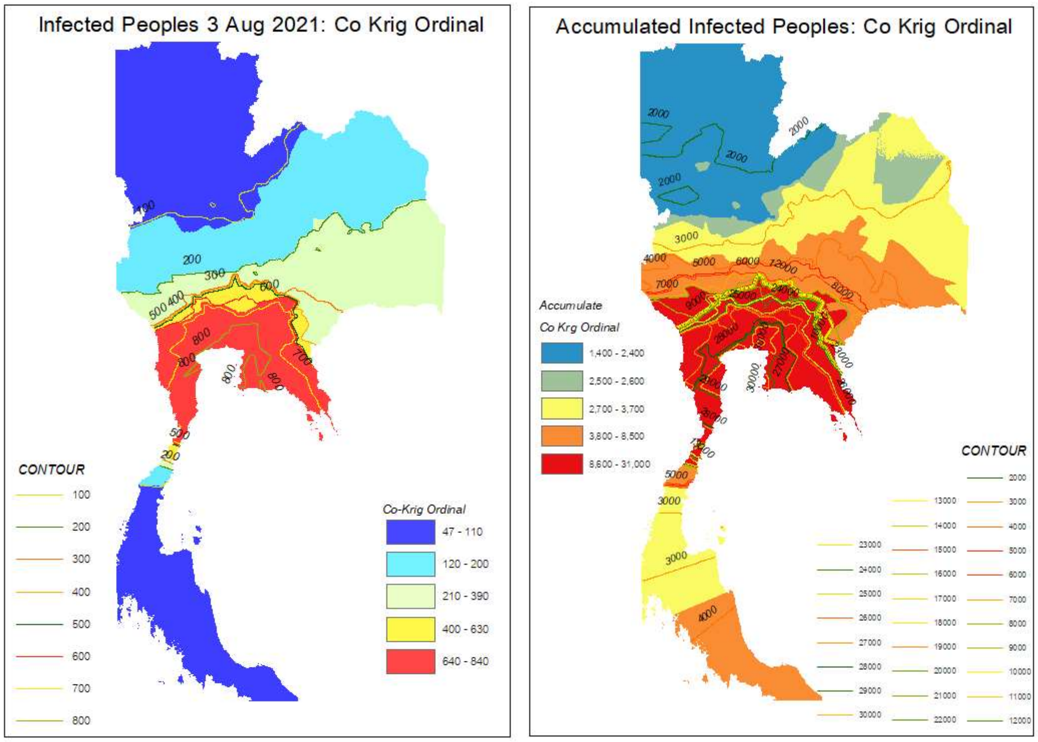


b) Cross-validation of Covid-19 infected peoples: April - 3 August 2021.

Figure 3. Semivariogram & Cross-validation of Covid-19 infected peoples: Accumulated April to 3 August 2021.

4. The Results.

From the co-kriging method to consider the semivariogram. Those achievements can be used to create an isarithm map, as shown in Figures 4a and 4b, with map symbols and isarithm lines as a summary of the situation of covid-19 infection cases in Thailand, according to the range. all the time specified.



a)Infected peoples 3 August 2021. b) Accumulated infected peoples, April-August 2021

Figure 4. Isarithm Mapping of Pandemic Covid-19 Significant Area.

5. REFERENCES

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