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# LAND USE INSPECTION TECHNIQUE AFFECTS LAND SURFACE TEMPERATURE FROM SATELLITE DATA

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## ABSTRACT

This research aims to present a land use inspection technique that affects land surface temperature from satellite data by using Maha Sarakham province, Thailand as a case study. Procedures: 1) Analyze land use from Sentinel-2 Satellite data that can be divided into 4 categories such as water, agriculture, forest, and urban, 2) Analyze land surface temperature from Sentinel-3 Satellite data. The study results found that urban area has the highest average surface temperature followed by forest area, water area, and agricultural area respectively. The analyzed data from the satellite found the highest average surface temperature is 32.20°C. The result shows that this inspection technique can analyze land surface temperature in other areas of the country.

**Keywords:** remote sensing; digital image processing; land surface temperature; sentinel-2, sentinel-3.

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## INTRODUCTION

In the past, most of the population in Thailand was farmers, and most of the areas were agricultural areas with less construction [1]. Nowadays Thailand has changed according to economic, social, and population [2], especially as the population increases the need for land use also increases. Then land use has been changed to urban or construction [3,4]. Regarding the limited size of area or land, land use will be substitution such as agricultural areas changed to commercial and residential areas [5]. The expansion of urban areas is a major factor that affects the change of land use, then agricultural areas have rapidly changed to community and commercial areas to satisfy the expansion of major cities. In addition, land use will cause soil temperature to be higher than in other areas, especially the areas of construction and building [6, 7].

Other research and relevant documents found that many researchers have studied land use from satellite data such as research by [9], and [10]. Further, many researchers give priority to the analysis of land surface temperature by using remote sensing technology from satellite data such as [11], [12], and [13]. Remote sensing technology is recognized as modern and effective technology [14-18] and can be applied to monitor and inspect other phenomena on the earth's surface promptly [19-25]. This research aims to present a land use inspection technique that affects land surface temperature from satellite data by using Maha Sarakham province, Thailand as a case study.

## STUDY AREA

Maha Sarakham province (Figure-1) is located at the center of the northeastern at longitude 102º 50´E and between latitude 16 º 40´N. It is above the sea between 130-230 meters and the average area is 5,300 km$^2$. General geography is mostly a plateau with no mountain; the northern and southern parts are alternately lowland and upland and gradually slope to the eastern plain area. Climate is divided into 3 seasons; winter starts from mid-October to mid-February, summer starts from mid-February to mid-May, and rainy starts from mid-May to mid-October. The average rain throughout the year is between 1,000 - 1,200 mm. This province is divided into 13 districts, 133 sub-districts, and 1, 944 villages.

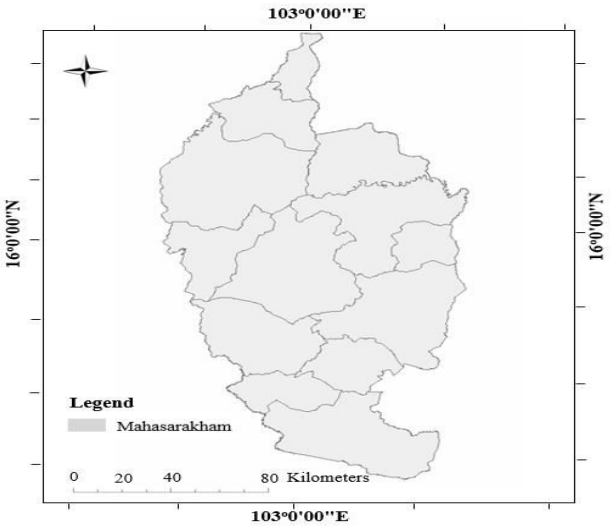


**Figure-1.** Maha Sarakham Province, Thailand.

## MATERIALS AND METHODS

### Satellite Data

Data from Sentinel-2 Satellite with Multi-Spectral Imager (MSI) System used to analyze land use. In this study, land use analysis is divided into 4 categories; water area, agricultural area, forest area, and urban area. Data from Sentinel-3 Satellite in Thermal Infrared

wavelength will be used to analyze land surface temperature.

**Land Temperature Data**

In this study, the researcher collected monthly average temperature data from ground stations in Maha Sarakham Province from the Thai Meteorological Department.

**Procedures**

This study concisely presents the procedures as the following steps:

- The analysis of land use Sentinel-2

Satellite data which was downloaded from Copernicus Open Access Hub (https://dataspace. copernicus.eu/) has been used to analyze land use and is divided into 4 categories as mentioned in Section 2.2. In this research, a researcher uses Supervised Classification in Maximum Likelihood Classification by mainly considering data in each category from the mean vector and covariance matrix. In addition, a researcher has a hypothesis that each category of land use will have a normal distribution of data, and then calculate the probability of each pixel.

- The analysis of land surface temperature

A researcher has input data from Sentinel-3 Satellite which was downloaded from Copernicus Open Access Hub *(*https://dataspace.copernicus.eu/) to analyze land surface temperature via a packaged program called The Sentinel Application Platforms or SNAP developed by European Space Agency. As data from Sentinel-3 Satellite is already in the form of land surface temperature but it is in Kelvin unit, a researcher has changed the temperature unit from Kelvin to Celsius and changed the coordinate system to Grid Coordinate or Universal Transverse Mercator (UTM) for Thailand (EPSG:32648 WGS 84 / UTM Zone 48N).

## RESULTS AND DISCUSSIONS

**Analysis Results of Land Use**

Analysis of results of land use was performed in 4 categories: water area, an agricultural area, forest area, and urban area found that 1) the size of the water area is 489.025 km$^2$ or 8.72%, 2) the size of the agricultural area is 4,192.104 km$^2$ or 74.75%, 3) the size of the forest area is 345.036 km$^2$ or 6.15%, and 4) the size of the urban area is 559.867 km$^2$ or 9.98% as shown in Figure-2. Using data from Sentinel-2 Satellite to analyze 13 districts of Maha Sarakham province separately (Table-1) found that most areas are agriculture. The first three districts that have the most agricultural area are 1) Kosum Phisai has an agricultural area of 577.50 km$^2$, 2) Borabue has an agricultural area of 538.83 km$^2$, and 3) The first three districts that have the most agricultural area are 1) Kosum Phisai has an agricultural area of 577.50 km$^2$, 2) Borabue has an agricultural area of 538.83 km$^2$, and 3) Phayakkhaphum Phisai has an agricultural area of 510.39 km$^2$. The first three districts that have the most forest area are 1) Kosum Phisai has a forest area of 80.52 km$^2$, 2) Chiang Yuen has a forest area of 45.38 km$^2$, and 3) Wapi Pathum has a forest area of 42.65 45.38 km$^2$.

The first three districts that have the most urban area are 1) Mueang Maha Sarakham has an urban area of 199.45 km$^2$, 2) Borabue has an urban area of 131.68 km$^2$, and 3) Kantharawichai has an urban area of 91.27 km$^2$. The first three districts that have the most water area are 1) Na Chueak has a water area of 73.35 km$^2$, 2) Wapi Pathum has a water area of 67.87 km$^2$, and 3) Kosum Phisai has a water area of 67.48 km$^2$.

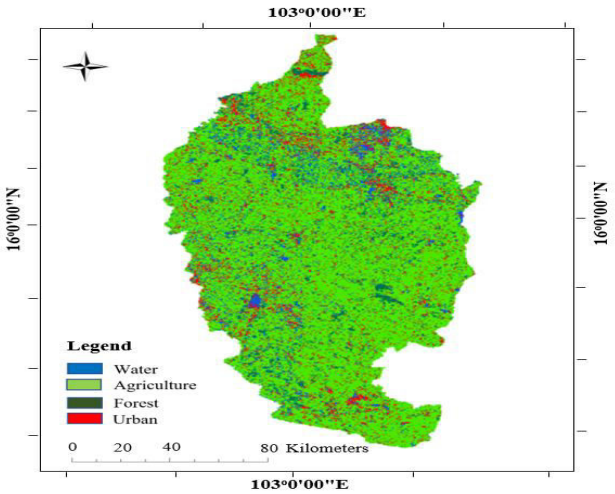


**Figure-2.** Analysis results of land use in 4 categories.

**Table-1.** Results of land use in 4 categories in 13 districts.

| Districts | Agricultural (km$^2$) | Urban (km$^2$) | Forest (km$^2$) | Water (km$^2$) | Total (km$^2$) |
|---|---|---|---|---|---|
| Mueang MahaSarakham | 317.39 | 213.90 | 30.68 | 12.28 | 574.28 |
| Kae Dam | 121.79 | 29.46 | 16.64 | 6.35 | 174.24 |
| Kosum Phisai | 577.50 | 57.28 | 80.52 | 67.48 | 782.78 |
| Kantharawichai | 281.94 | 91.27 | 26.20 | 3.67 | 403.08 |
| Chiang Yuen | 206.06 | 43.15 | 45.38 | 23.82 | 318.41 |
| Borabue | 538.83 | 131.68 | 16.83 | 12.20 | 699.54 |

| | | | | | |
|---|---|---|---|---|---|
| Na Chueak | 311.78 | 62.55 | 18.68 | 73.35 | 466.36 |
| Phayakkhaphum Phisai | 510.39 | 57.24 | 35.37 | 4.42 | 607.42 |
| Wapi Pathum | 466.21 | 55.40 | 42.65 | 67.87 | 632.13 |
| Na Dun | 152.51 | 84.11 | 15.08 | 1.12 | 252.82 |
| Yang Si Surat | 157.18 | 27.90 | 17.79 | 15.55 | 218.42 |
| Kutrang | 241.89 | 43.51 | 26.52 | 13.24 | 325.16 |
| Chuen Chom | 56.47 | 58.38 | 13.91 | 2.43 | 131.19 |
| Total | 3939.94 | 941.38 | 400.73 | 303.78 | 5585.83 |

**Analysis Results of Land Surface Temperature**

Analysis results of land surface temperature from Sentinel-3 Satellite data in Thermal Infrared wavelength shown in Figure-3 found that the highest temperature is 32.20°C, the lowest temperature is 25.09°C, and the average temperature is 28.64°C. For the maximum benefits in this study, a researcher has analyzed the temperature of 13 districts in Maha Sarakham province separately as shown in Table-2. Table-2 shows the analysis results of land surface temperature of each district and found that the first three districts that have the highest average temperature are 1) Yang Sisurat has an average land surface temperature of 32.04°C, the highest land surface temperature of 33.17°C, the lowest land surface temperature of 30.90°C, and mostly is an agricultural area, 2) Chuen Chom has an average land surface temperature of 31.36°C, the highest land surface temperature of 32.20°C, the lowest land surface temperature of 30.52°C, and mostly is an agricultural area, and 3) Kut Rang has an average land surface temperature of 30.98°C, the highest land surface temperature of 31.83°C, the lowest land surface temperature of 30.12°C, and mostly is an agricultural area.

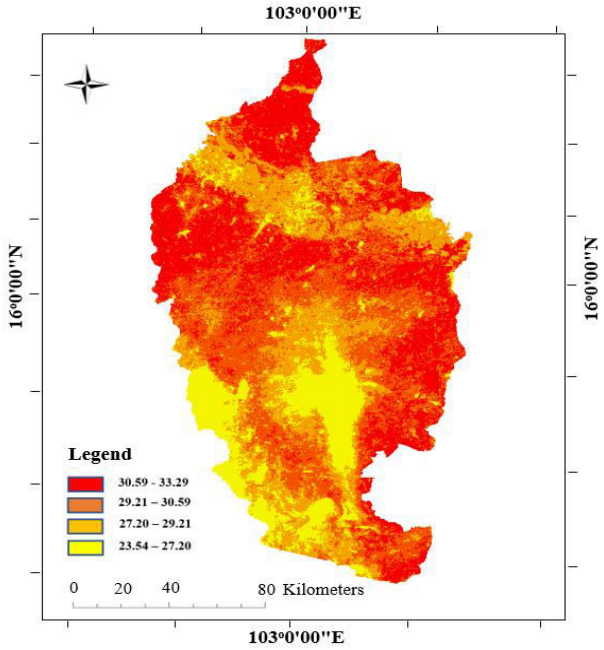


**Figure-3.** Analysis results of land surface temperature.

**Table-2.** Results of land surface temperature in 13 districts.

| Districts | Agricultural ($km^2$) | Urban ($km^2$) | Forest ($km^2$) | Water ($km^2$) | LST (°C) |
|---|---|---|---|---|---|
| Mueang MahaSarakham | 317.39 | 213.90 | 30.68 | 12.28 | 29.23 |
| Kae Dam | 121.79 | 29.46 | 16.64 | 6.35 | 29.23 |
| Kosum Phisai | 577.50 | 57.28 | 80.52 | 67.48 | 29.33 |
| Kantharawichai | 281.94 | 91.27 | 26.20 | 3.67 | 29.17 |
| Chiang Yuen | 206.06 | 43.15 | 45.38 | 23.82 | 30.51 |
| Borabue | 538.83 | 131.68 | 16.83 | 12.20 | 30.31 |
| Na Chueak | 311.78 | 62.55 | 18.68 | 73.35 | 29.78 |
| Phayakkhaphum Phisai | 510.39 | 57.24 | 35.37 | 4.42 | 30.59 |
| Wapi Pathum | 466.21 | 55.40 | 42.65 | 67.87 | 29.99 |
| Na Dun | 152.51 | 84.11 | 15.08 | 1.12 | 30.08 |
| Yang Si Surat | 157.18 | 27.90 | 17.79 | 15.55 | 32.04 |
| Kutrang | 241.89 | 43.51 | 26.52 | 13.24 | 30.98 |
| Chuen Chom | 56.47 | 58.38 | 13.91 | 2.43 | 31.36 |

**Changing Analysis**

Changing analysis for land use in 4 categories that affect land surface temperature found that urban area has an average temperature of 30.59 - 33.29°C, the agricultural area has an average temperature of 29.21-30.59°C, forest area has an average temperature of 27.20-9.21°C, and water area has an average temperature of 23.54-27.20°C. The study result of the measurement of spatial land surface temperature is shown in Figure-4. Figure-4 shows that Maha Sarakham province has 13 districts represented by a graph line in the X-axis which land use in the districts is divided into 4 categories: water area, agricultural area, forest area, and urban area. The hypothesis of this research is urban area in each district has higher temperatures than other categories of land use. The graph line in the Y-axis on the left side represents the area size of land use, the unit is $km^2$ and on the right side represents the temperature, the unit is °C. Figure-4 represents that the graph line of temperature will be changed according to land use in each category of each district.

The results found that three districts which are Yang Sisurat, Chuen Chom, and Kut Rang have the highest land surface temperatures in urban areas which are 32.04°C, 31.36°C, and 30.98°C respectively. Three districts which are Kantharawichai, Mueang Maha Sarakham, and Kae Dam have the lowest land surface temperatures in urban areas which are 30.33°C, 30.46°C, and 31.01 °C respectively. Analysis results of land surface temperature relate to land use which means the analyzed land surface temperature in urban areas will have the highest temperature, followed by agricultural area, forest area, and water area respectively.

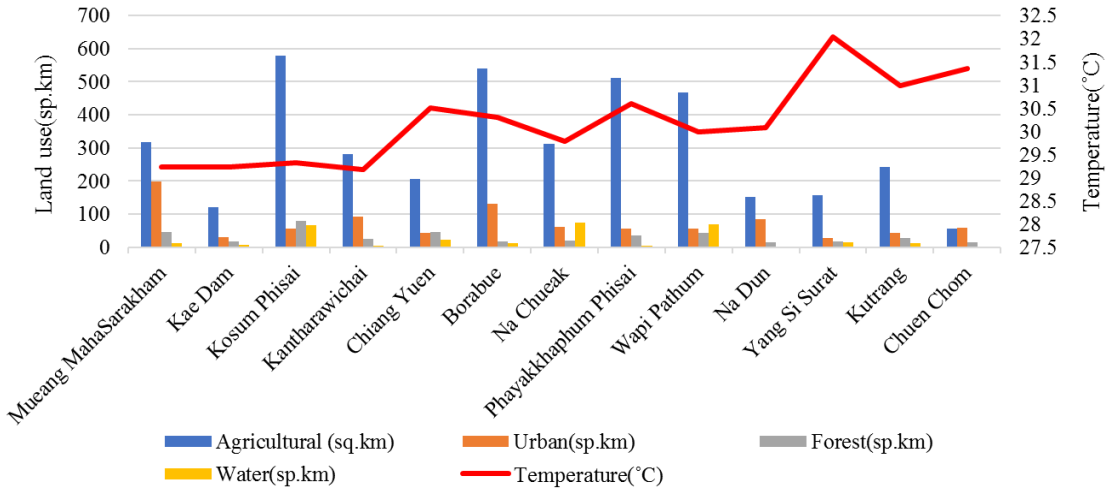


**Figure-4.** Changing analysis for land use in 4 categories that affect land surface temperature.

## CONCLUSIONS

This study found that the urban area has the highest average land surface temperature of 32.20 °C and the urban area of each district has a land surface temperature higher than the temperature of other categories of land use as most of the constructions are located in urban areas. When examining the analyzed land surface temperature with the temperature of the Thai Meteorological Department found a 3.87% discrepancy. The analyzed data from the satellite found a land surface temperature of 32.20 °C while data from the Thai Meteorological Department has a temperature of 31.00 °C which assumes that the position to measure the temperature of the Thai Meteorological Department has only one position which is Kosum Phisai District and data from the only one position cannot represent the temperature of the entire province. On the other side, data from the satellite which is analyzed from every square inch of the entire province has a higher average temperature than the Thai Meteorological Department.

## ACKNOWLEDGEMENTS

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