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AN ANALYSIS OF LAND SURFACE TEMPERATURE AND LAND-USE FROM SENTINEL SATELLITE DATA

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ABSTRACT

Land surface temperature is a study of the heat on the earth's surface; it can be recognized by contacting the surface from Thermal Infrared wavelength which can be the roof, the top of buildings, water, or ice. Therefore, land surface temperature and air temperature are not the same. This study aims to analyze land surface temperature and land-use from Sentinel-2 Satellite data. The procedure is divided into 3 main steps: 1) Using data from Sentinel-3 Satellite to analyze temperature by using The Supplemental Nutrition Assistance Program (SNAP) program, 2) Land-use classification by using data from Sentinel-2 Satellite in Supervised Classification in the form of Maximum Likelihood Classifier. This study has classified land-use into 4 types: water, forest, urban, and agriculture, 3) Accuracy assessment. The result found that the land surface temperature of urban areas has the highest average land surface temperature, followed by forest, agriculture, and water.

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

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INTRODUCTION

Green areas are defined as natural areas and created or designated areas by humans that have benefits to the environment, ecosystem, living, and quality of life for people [1]. Urban expansion causes a high density of dwellings and it constantly increases the temperature [2]. In addition, land surface temperature change in urban areas increases according to the expansion of land cover in terms of constructions to support social and economic growth [3], then in other countries have systematic green areas allocation. Bangkok, the capital of Thailand, has green areas of only 3.24 square kilometers per person in 2021 [4]. Thailand has a proportion for urban areas of 49%, and rural areas of 51%, it can be seen that green areas are highly decreased which may be caused by urban expansion constantly which affects the increase of heat value and impacts people residing in the study area [5]. However, green areas often have an inverse relationship with temperature, then it is an interesting issue to be analyzed [6]. Mueang District of Maha Sarakham province has urban expansion in terms of the number of populations, social and economic where land-use has been changed to construction. This province is in the strategic framework for the development of transportation infrastructure which causes rapid economic and urban expansion, then land-use is different from the past.

Other research and relevant documents in the analysis of land surface temperature found that many researchers have analyzed land surface temperature from satellite data such as the study of urban surface temperature change, the study of urban heat island: UHI phenomenon, and measuring and specifying wildfire area from land surface temperature [7-10]. Currently, many researchers give priority to the development of measuring land surface temperature by using remote sensing technology from satellite data which can record any phenomenon on the earth's surface using electromagnetic waves to reflect to sensor equipment installed on the satellite [11-15]. Remote sensing technology has been recognized as an updated and efficient technology and can be applied to monitor and inspect any phenomenon arising on the earth's surface [16-25]. Other research has developed a methodology to analyze land surface temperature with satellite data [26-29]. Regarding the significance of climate change and the increasing of such temperatures, this study aims to analyze land surface temperature and land-use from Sentinel Satellite data in 2023.

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. General geography is mostly a plain to ripple slope and it is above the sea between 130-230 meters. Its climate is influenced by southwest monsoon and northeast monsoon which cause 3 seasons: rainy, winter, and summer. Southwest monsoon blows from the Indian Ocean, and the period between mid-May to October is the rainy season while the northeast monsoon blows from the northern part of China which brings cold and drought to Thailand, this period is winter which starts from November to February, and the summer is from March to April.

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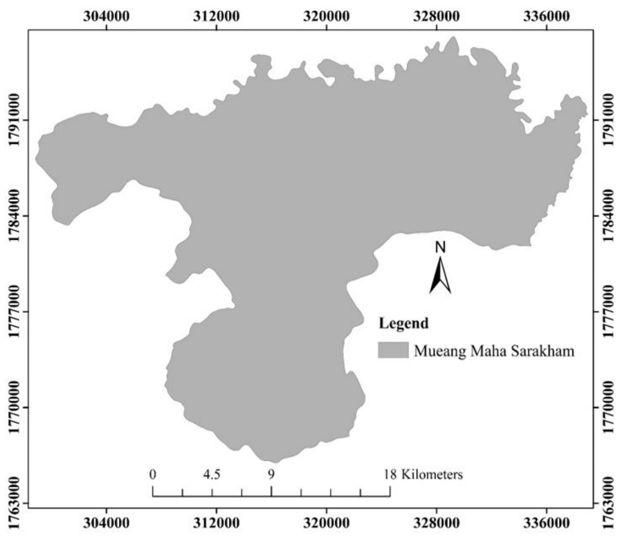

Figure-1. Mueang Maha Sarakham, Maha Sarakham Province.

MATERIALS AND METHODS

Satellite Data

The analysis of land surface temperature in this study uses Sentinel-3 Satellite data (SLSTR Level-2 LST product) while Land-use classification uses Sentinel-2 Satellite data (Product Type S2MSI1C). Both data from Sentinel-3 and Sentinel-2 will be selected from the data of minimal overcloud for each month in 2023.

Land Temperature Data

This study collects the average monthly temperature data from the field station of the Meteorological Department which is located in Maha Sarakham province.

Procedures

This study concisely presents the procedures as the following steps:

- Analysis of land surface temperature

Input Sentinel-3 Satellite data to Snap program as this data (SLSTR Level-2 LST product) is already in the form of land surface temperature but it is in Kelvin unit, the researcher has changed the temperature unit from Kelvin to Celsius and changed the system to coordinate system in Geographic Lat/Lon WGS 84.

- Land-use classification

This study uses Sentinel-2 Satellite data to classify land-use into 4 types: water, forest, urban, and agriculture. The methodology uses supervised classification in the form of Maximum Likelihood Classification considering the mean vector and covariance matrix for each type of data by making a hypothesis that each type of data has a normal distribution and calculating the probability of each pixel it has been classified to what type.

- Accuracy assessment

The researcher uses overall accuracy analysis to represent the accuracy of data classification that conforms with checkpoint and reference data and is calculated as a percentage of all checkpoints regardless of any error which is the consideration of overall classified data level and represents to single accuracy.

RESULTS AND DISCUSSIONS

Analysis Result of Land Surface Temperature

The analysis of land surface temperature data from Sentinel-3 Satellite at Mueang District, Maha Sarakham province using the Snap program is shown in Figure-2 and Table-1. It is found that in 2023 Mueang District, Maha Sarakham province has the highest temperature of 33.57 degrees Celsius, the lowest temperature of 26.98 degrees Celsius, and the average temperature of 30.28 degrees Celsius. The researcher compares the temperature data from the field station of the Meteorological Department in Maha Sarakham province with the analyzed data from Sentinel-3 Satellite to determine land surface temperature by using the period for collecting temperature data provided that such data will be in the same month and year. This comparison result is shown in Table-2.

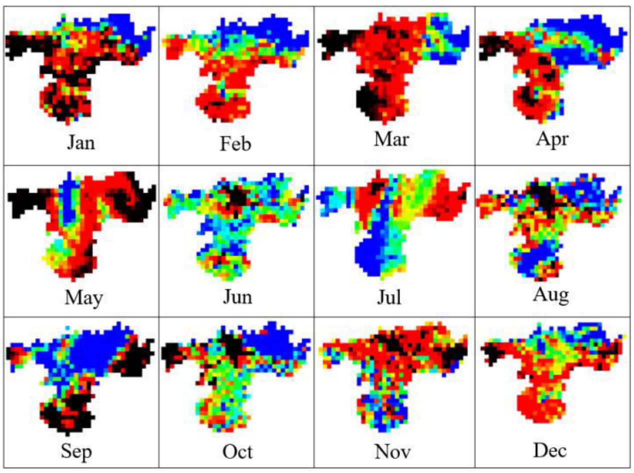

Figure-2. Analysis result of land surface temperature.

Table-1. Results of monthly soil surface temperature analysis.

Year	Month	Temperature value (degrees Celsius)			
		Min	Max	Mean	Standard Deviation
2023	Jan	32.24	36.52	34.38	3.03
	Feb	32.72	37.89	35.31	3.65
	Mar	14.90	34.22	24.56	13.66
	Apr	37.40	43.29	40.34	4.16
	May	24.26	33.51	28.89	6.54
	Jun	31.26	33.28	32.27	1.43
	Jul	15.48	28.80	22.14	9.42
	Aug	31.76	33.62	32.69	1.31
	Sep	15.62	23.89	19.76	5.84
	Oct	31.67	34.00	32.83	1.65
	Nov	29.36	33.28	31.32	2.78
	Dec	27.11	30.54	28.82	2.43
	Average	26.98	33.57	30.28	4.66

Analysis Result of Land-Use

The analysis result of land-use from Sentinel-2 Satellite data can be classified into 4 types: water, forest, urban, and agriculture which is shown in Figure-3 and Table-2. It is found that agriculture has the most area 436.53 square kilometers or 76.07%, followed by water area 56.85 square kilometers or 9.91%, urban area 43.94 square kilometers or 7.66%, and forest area 36.54 square kilometers or 6.37%.

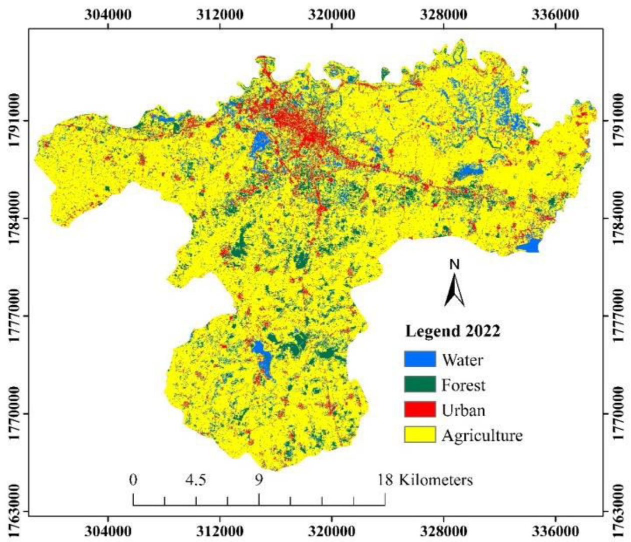

Figure-3. Spatial analysis result of land use.

Table-2. Land-use classification.

Land Use Type	Number of Pixel	Area (Km^2)	%
Water	568,528	56.85	9.91
Forest	365,395	36.54	6.37
Urban	439,421	43.94	7.66
Agriculture	4,365,308	436.53	76.07
Total	5,738,652	573.87	100.00

Accuracy Assessment

The result of the accuracy assessment for land-use classification is shown in Table-3. The researcher assesses the accuracy for all 80 classifications which are divided into 4 types: water, forest, urban, and agriculture, each type has 20 classifications. The water area has 14 accuracy classifications, with errors for forest area 3 classifications, urban area 2 classifications, and agricultural area 1 classification, then the accuracy is 70%. Forest area has 18 accuracy classifications, with errors for urban area 1 classification, and agricultural area 1 classification, then the accuracy is 88%. Urban area has 15 accuracy classifications, with errors for water area 2 classifications, and agricultural area 3 classifications, then the accuracy is 74%. The agricultural area has 18 accuracy classifications, with errors for urban area 2 classifications, then the accuracy is 90%. The overall accuracy assessment for the 4 types has an overall classification accuracy of 81.25%.

Table-3. Accuracy assessment for land-use classification.

Land Use Type	Water	Forest	Urban	Agriculture	Total	%
Water	**14**	3	2	1	20	70.00
Forest	0	**18**	1	1	20	88.00
Urban	2	0	**15**	3	20	74.00
Agriculture	0	0	2	**18**	20	90.00
Total	16	21	20	23	80	100.00

CONCLUSIONS

The analysis of land surface temperature and land-use from Sentinel Satellite data summarizes that green area (forest and agricultural area) influences the inverse change of land surface temperature. The result found that if it has more green area, land surface temperature will be low because green area absorbs the sun's energy less than buildings, houses, and constructions. Green area affects the reduction of land surface temperature accordingly which conforms with research [30-32] which summarizes that green areas significantly affect the reduction of land surface temperature.

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