RESEARCHING ON THE EFFECTS OF LAND USE CHANGES TO THE CHANGE OF SURFACE TEMPERATURE IN DANANG CITY

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ABSTRACT

Using remote sensing aimed to study the effects of land-use change to the change of surface temperature in Danang city. The research results showed that the emission value of the time is rather similar but it is very different among the land utilization types (LUT). The buffering surfaces such as urban land has lower emissive values than land types with vegetation-covered in a large area, such as production forest land, natural forest, ... From the maps of the temperature change in several stages in Danang city proclaimed the close relation between land-use change and temperature change. LUT from agricultural land transferred to non-agricultural land showed a dramatic temperature increase. On the other hand, LUT from unused-land transferred to agricultural land showed a lower temperature increase. The research results can be useful for urban planning to adapt with rising temperature in the future.

Key words: Temperature change; thermal remote sensing; land utilization types; buferring surface; Danang city

1. INTRODUCTION

When it comes to temperature in a given area that is the temperature of the layer of air close to the ground. In addition to solar radiation, the surface of the buffer plays an important role for the surface temperature. Padded surface may be land or water, with vegetation cover or covered with snow. Padded surface frequently changing and heterogeneous across sectors, regions. The main reason is due to the speed of economic development - different societies, and in particular the process of urbanization. Urbanization has formed many impervious surfaces such as ground transportation, urban land, land to build factories and industrial parks The area of impervious surface increases greatly affects the temperature of the urban, causing the phenomenon of "urban heat island". This phenomenon is at the same time but the temperature in urban areas is much higher than in rural areas, the areas with thick vegetation cover.

Da Nang is the social and economic center of Central. The process of urbanization of the city and going on strong. Besides the positive side, urbanization has significantly affected the temperature of this region. Accordingly, the temperature of the central city of Da Nang is high. Therefore, the study of the impact of land-use change to temperature change has important

implications.

Thermal remote sensing is a powerful tool to study the surface temperature changes quite detailed and does not depend on the weather station. In this theme we used Landsat to study the impacts of land use to change the temperature in the city of Da Nang.

2. RESEARCH METHODOLOGY

2.1. Overview of the study area

The study area is the entire land area of the city of Da Nang. This area is located in the tropical monsoon humidity, high temperatures and low volatility. The annual average temperature is about 25.9^0C, each year there are 2 distinct seasons: the rainy season lasts from August to December and the dry season from January to July.

2.2. Research data

The topic was the use of Landsat then to calculate the impact of temperature variations land use change map:

In 1990: Landsat Thematic Mapper (TM), taken on 05/17/1990.

In 2000: Landsat Thematic Mapper Enhanced Plus (ETM +) taken on 5/7/2000.

In 2013: The Operational Land Imager Landsat (OLI) taken on 19/05/2013.

2.3. Research Process

The study of the impact of land use change to temperature change is shown in the following diagram:

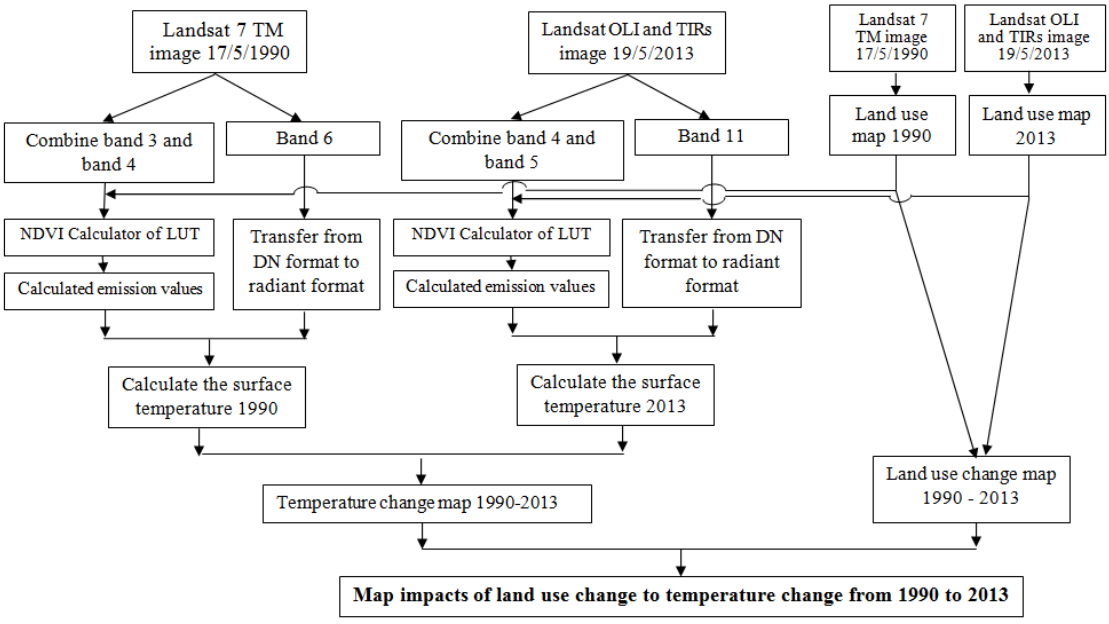

Figure 1. Process to study the effect of temperature in land use change from 1990 to 2013 in the city of Da Nang

In addition, subjects using Landsat ETM+ taken on 07/05/2000 to calculate the temperature and land use in 2000. Since then, the subject carried out calculations of land-use

change and fluctuating temperatures city of Danang period 1990-2000 and 2000-2013. Finally, the topic of mapping the impact of land-use change to temperature fluctuations Danang period 1993-2013.

In the process of implementing the subject, the author has combined GIS and remote sensing software to analyze this effect.

- Remote Sensing Software: Used to edit photos, calculate NDVI values, calculated from the radiation transfer value into a DN form of radiation, surface temperature calculation.

- GIS software: Used to fix the image, calculating the value of surface emissivity, spatial analysis, to determine the impact of land use change to temperature variations.

3. THE RESEARCH CONTENTS

3.1. Calculate the emissivity

Between land use types (LUT) different, the emissivity is very different from each other. If we take an emissivity value for the whole territory, it will send the temperature will be great to have more LUT territory. Therefore, to improve the accuracy of the determination of the surface temperature, it is necessary to calculate the emissivity of each LUT. Van de Griend and Owe (1993) have performed experiments directly measuring the emissivity and reflectance spectra in the range of visible and near-infrared to calculate NDVI and found the empirical relationship between emissivity and NDVI as follows:

$$\varepsilon = a + b.\ln(NDVI)$$

$$\text{with } a = 1.0094 \text{ and } b = 0.047$$

This formula applies to areas where uniformity and NDVI values> 0. Therefore, in this study, the authors have separated all the different LUT and eliminate areas where NDVI <0. After which conducted emission value calculation of each LUT to ensure accuracy.

3.2. Calculate the value of radiation

The calculation of the temperature of the Landsat TM based on 6 channels, this channel contains information about the surface temperature of the study area. Thermal bands of Landsat ETM + Low gain in two states (channel 6_1) and High Gain (Channel 6_2), in this topic we used to calculate the channel 6_2 surface temperature. For Landsat 8 Operational Land Imager (OLI), the temperature value is calculated based on channel 11.

Table 1. Information of Landsat thermal bands

	L_{max}	L_{min}	$Qcal_{max}$	$Qcal_{min}$
Landsat TM	15.303	1.238	255	1
Landsat ETM+	12.650	3.200	255	1
Landsat OLI	22.0018	0.1003	65535	1

Heat acquire canal pixel values should form the first businesses moving subject DN pixel values from the form into a radiation according to the formula:

L_λ = ((Lmax - Lmin) / (Qcalmax - Qcalmin)) * (Qcal - Qcalmin) + Lmin

Applying the values from Table 1, we have the formula for calculating the emission values

for each type of Landsat as follows:

- Landsat TM:

$L_\lambda = 0.055374016 * (B1-1) + 1238$

- Landsat ETM+:

$L_\lambda = 0.037204724 * (B1-1) +3.2$

- Landsat OLI:

$L_\lambda = 0.0003342 * (B1-1) + 0.10033$

Then, continue to adjust the parameters as wavelenghts, Sizes and sensor pixels for each image type.

3.3. Calculate the surface temperature

After calculating the value of surface emissivity of each LUT in the time of 1990, 2000 and 2013. This study was carried calculate the surface temperature according to standardized algorithms emission values NOR (Emissivity Normalization Method). Because the temperature is calculated in units of Kelvin, we will transfer the value ^{0}C by the formula:

$$T^0C = T (Kelvin) - 273.16$$

The surface temperature depends on three factors: solar radiation, atmospheric circulation and surface buffer. On the basis of data on the current use of the land to be interpreted from remote sensing images, we have built a map of land use change. In this study, we rely on non-volatile land to remove the influence of solar radiation and atmospheric circulation at different times to temperature. If the value of radiation and atmospheric circulation, the same type of soil movement (same side buffer time before and after) will have the same temperature. However, due to the effects of radiation and atmospheric circulation so even the type of soil temperature fluctuations are also different. So the theme based on the temperature difference fluctuations of soil to adjust the cushion surface fluctuations of equal value. Thereby, we can eliminate the influence of solar radiation and atmospheric circulation to surface temperature.

3.4. Analysis of the impact of land-use change to temperature fluctuations phase 1990-2013

After calculate the temperature distribution in the space between the time of 1990, 2000 and 2013. Topical use of GIS software to determine the temperature variation between the periods 1990-2000, 2000-2013 and 1990-2013 Danang. On the basis of data land use to be interpreted from remote sensing images, we construct a map of land use change periods. Since then, the subject carried out calculations, analyze the impact of temperature variations land use change to the period 1990-2013, 2000-2013 and 1990-2013.

4. RESULTS OF THE STUDY

4.1. Determining the value of emission

This study was carried NDVI calculated for each LUT and then calculating the value of emissivity ε by the formula of Van de Griend and Owe (1993)

$$\varepsilon = a + b.\ln (NDVI)$$

with a = 1.0094 and b = 0.047

The topic has removed areas with NDVI values <0, the majority of the land area of the river, the water. Results calculated emission values as follows:

Table 2. The value of the emission of the type used at the time

LUT	Emission values		
	1990	***2000***	***2013***
Unused land (BCS)	0.906273	0.905508	0.888133
Perennial crop land (CLN)	0.934775	0.936285	0.934854
Unused hilly land (DCS)	0.908643	0.907121	0.901747
Annual crop land (HNK)	0.910354	0.910958	0.922007
Rice land (LUA)	0.936443	0.927391	0.934381
Urban land (ODT)	0.889143	0.881655	0.873874
Rural land (ONT)	0.903784	0.900156	0.905208
Productive forest land (RSX)	0.941664	0.941635	0.942729
Natural Forest (RTN)	0.965543	0.962179	0.956759

In Table 2 shows the average emission value of the time there is no much difference. However, the emission values of the LUT huge difference. The padded surface such as urban land, unused land in lower value than those soils with vegetation covers a large area, such as production forest land, natural forest, woodland perennial, paddy land. The remaining soil types have an average emission value.

4.2. Temperature change Danang the 1990-2000, 2000-2013 and 1990-2013

Temperature value from the temperature distribution maps were calculated on remote sensing software. After calculating the temperature of each period, subjects had to remove the effects of solar radiation and atmospheric circulation of the various periods up to temperature by calculating the temperature difference of the land does not fluctuate . Through calculation, the temperature difference between the land of volatility in 2013 is higher than 2000 and 1990 is 1.43^0C 0.54^0C. The reason for the difference value is so taken by the Landsat images in different times, so the solar radiation and different atmospheric circulation. Moreover, ground temperatures are influenced by the phenomenon of cyclical changes in nature as Nino or La Nina En ... Based on the above results, the subject had to adjust the temperature in 1990 and 2000 by temperature plus the time value of 1.43^0C and 0.54^0C, respectively. Then, we established map temperature variations Danang stages. In this paper, we demonstrated in phase 1990-2013.

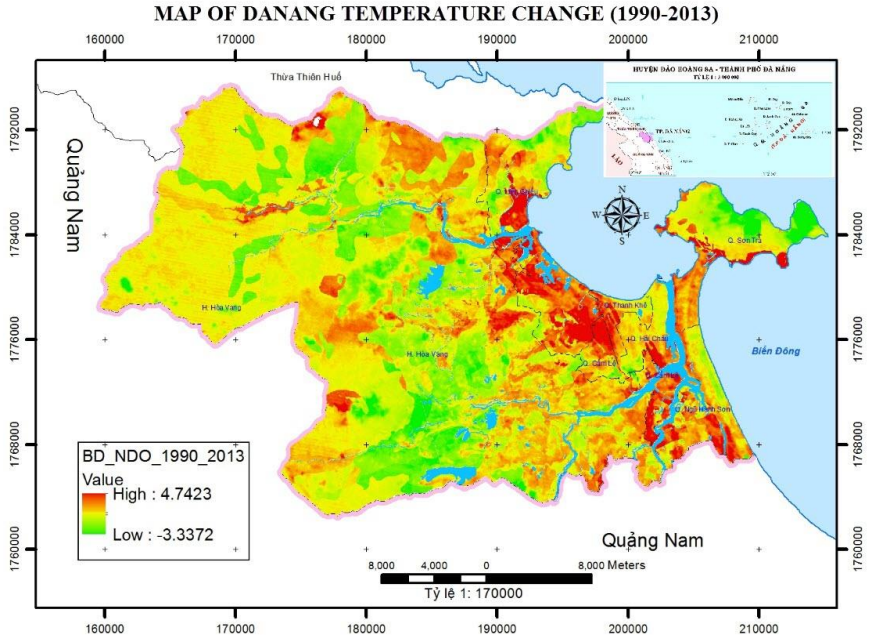

Figure 2. Map of Danang temperature change 1990-2013 (scaled from 1: 170000)

4.3. The impact of temperature variations in land use change in the stage 1990-2013

Combining land use change maps and map temperature variations, subjects were mapping the correlation between temperature variation and land use change in the stages 1990-2000, 2000-2013 and 1990-2013. In this paper, we only show the map between 1990-2013. The results are shown in the following figure:

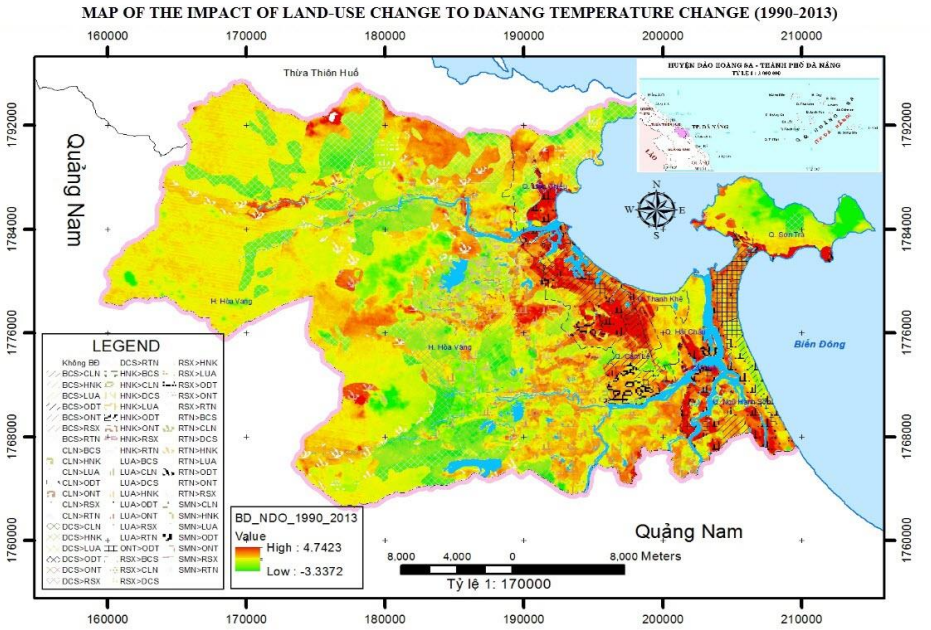

Figure 3. Map of the impact of land use change to Danang temperature change (1990-2013)

Table 3. Statistics of land use change to the effects of temperature change from 1990 to 2000 in Da Nang (^{0}C)

1990	In 2000								
	BCS	CLN	DCS	HNK	LUA	ODT	ONT	RSX	RTN
BCS				-0.82	-1.22	2.35	0.90	-2.32	
CLN			2.26				2.17	-0.89	
DCS		-1.19			-1.10		-0.25	-1.35	-2.79
HNK		-0.56			-0.27	3.16	1.35	-1.16	
LUA	1.93	-0.15		-0.92		3.24	1.54	-0.30	
ODT									
ONT						2.22			
RSX		0.32	2.17			3.58	2.46		-1.19
RTN	3.69	1.96	3.25		2.13		2.84	1.53	

Table 4. Statistics of land use change to the effects of temperature change from 2000 to 2013 in Da Nang (^{0}C)

2000	2013								
	BCS	CLN	DCS	HNK	LUA	ODT	ONT	RSX	RTN
BCS						2.20			-2.91
CLN				0.86	-0.52	3.35	2.15	-0.62	-1.17
DCS				-1.08	-1.17	2.00	-0.27	-1.64	-2.50
HNK					-0.25	3.18	1.34	-0.97	
LUA	2.04	-0.15	1.65	-0.71		3.28	1.43	-0.27	
ODT									
ONT						2.19			
RSX	2.73	0.36	2.27	1.23	0.64	3.57	2.39		-1.27
RTN			3.25		2.01	4.30	2.93	1.43	

Table 5. Statistics land use change to the effects of temperature change in the phase from 1990 to 2013 in Da Nang (^{0}C)

1990	2013								
	BCS	CLN	DCS	HNK	LUA	ODT	ONT	RSX	RTN
BCS		-1.42		-0.94	-1.13	2.28	0.87	-2.12	-3.29
CLN				0.90	-0.63		2.04	-0.74	-1.44
DCS		-1.23		-1.01	-1.11	2.18	-0.30	-1.20	-2.56
HNK	1.82	-0.43			-0.33	3.02	1.42	-1.02	-1.82
LUA	2.22	-0.12	1.53	-0.82		3.27	1.66	-0.24	-1.23
ODT									
ONT						2.16			
RSX		0.41		1.35	0.82	3.61	2.31		-1.08
RTN		2.04	3.37	2.25	2.12	4.11	3.16	1.66	

Table 6. Statistics land use change impact of major soil groups to change the temperature stages from 1990 to 2013 in Da Nang (^{0}C)

1990	2013			
	CSD	SXN	LNP	OTC
CSD		- 1.12	-2.34	1.52
SXN			-1.13	
LNP		1.69		3.38
OTC				

In Table 3, 4, 5, 6, and Figure 2, 3 shows the impact of value of land use change to the temperature change between the periods do not differ much. However, between land use change and temperature variations are related closely. For the type of use of agricultural land to non-agricultural land transfer, the temperature rises very sharply, higher than the average for non-volatile soils. For example, to counter increasing 3.38^{0}C from LNP, LNP to increase 1.69^{0}C SXN. The LUT is CSD switched to agricultural land, the temperature dropped. For example, the CSD to SXN 1.12^{0}C temperature drops, the CSD to reduce 2.34^{0}C temperature LNP. However, CSD switched to OTC soil temperature is increased (1.52^{0}C). The reason for this difference is due to the surface of the buffer at different LUT. Non-agricultural land with impervious surface lot. Besides, the production and business activities in this area has discharged a large amount of excess heat. All made higher temperatures than those where there is vegetation cover.

Table 7. Statistics temperature changes according to the administrative unit of the period

District	1990	2000	2013
Dist . Hải Châu	35.33	36.49	37.16
Dist. Thanh Khê	34.31	36.62	37.08
Dist. Sơn Trà	27.92	28.114	28.97
Dist. Cẩm Lệ	32.12	32.684	34.66
Dist. Liên Chiểu	28.92	30.866	31.54
Dist. Ngũ Hành Sơn	33.54	33.005	35.24
Dist. Hòa Vang	27.70	27.729	28.19
Average Temparature	**28.32**	**28.62**	**29.17**

In Table 7 shows us the city temperature differentiation and spatial variation is quite clear. The densely populated districts and factories and enterprises, the temperature increase is much higher than other areas. The period 2000-2013 with the change in temperature is higher than 1990-2013. Summing two periods, the value of the temperature change of the city 1990-2013 is 0.85^{0}C.

5. CONCLUSION

From the research results to the effects of temperature variations in land use change Danang period 1990-2013, the subject can draw the following conclusions:

Between the LUT has a far different emissivity, the emissivity values calculated based on NDVI will limit the uncertainty in the calculation of the surface temperature.

The study results were calculated temperature variation of Danang 1990-2013. Areas with the process of urbanization, the temperature rises sharply higher than the average. Based on this analysis, it is possible to recognize the impact of land use change to the change of temperature at a certain area. The conversion of agricultural land and unused land into non-agricultural higher temperatures, from unused agricultural land to low temperatures than average.

Along with the climate change in the direction of increasing temperature, the process of urbanization has also contributed significantly to the increase in temperature of the city. Findings of the study may be useful for urban planning to adapt to rising temperatures in the coming time.

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