

APPLICATION OF THERMAL REMOTE SENSING TO STUDY OF LAND SURFACE TEMPERATURE AS INDICATOR LAND COVER CHANGE IN WETLAND AND VEGETATION

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ABSTRACT

Wetlands are a vital component of land cover in reducing impacts caused by urban heat effects and climate change. Technology remote sensing provides historical data that can study the impact of development on the environmental and local climate. The studies of wetland in reducing Land surface temperature (LST) in tropical climate still lacking. In the first step, pre-processing, namely geometric correction, atmosphere correction, and radiometric correction, need to be performed before to retrieval of LST from thermal band Landsat 5 and 8. In the third step Iso Cluster, unsupervised choose to produce with the land cover map for 1988 and 2019. Geographical Information System (GIS) technology was utilized to determine land cover change and LST change between the years 1988 and 2019. With GIS technology can study the impact of wetland deforestation on local temperatures at a local scale. Next to that, correlations between LST and the wetland were analyzed. The result shows the different land cover between the years 1988 and 2019. The area of land cover wetland and vegetation decrease and area of urban increase. The land cover changes the influence of LST significantly in the study area. For example, the wetland has a noticeable influence on LST. The LST increases with decreasing in areas wetland. Every 5-kilometer square (km²) wetland lost an increase in 1-degree Celsius of LST. The size area of wetland influence on LST was significant.

ARTICLE INFO

Keywords:

LST, Land Cover, Surface Urban Heat Island, Remote Sensing, and GIS

Article History:

Received: 10 Dec 2020

Revised: 11 Jan 2021

Accepted: 21 Feb 2021

Available Online: 02 Mar 2021

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1. INTRODUCTION

Wetland well-knowns as the kidney of the earth. The total of the global wetland more than 12.8 million km² (Board MEA, 2005). Wetland of the significant ecosystem in the world, along with forest and ocean (Board MEA, 2005). Wetland contains high biodiversity and plentiful ecological roles, namely source, guideline, sustenance, and cultural functions (Guo et al., 2017). The remote sensing technique is widely used for monitoring wetland and spatial distribution and spatial-temporal (Diaz et al., 2016; Betbeder et al., 2015; Anderson et al., 2012). However, the thermal infrared data less often used. The application of thermal infrared remote sensing such as Landsat able to understand the spatial distribution of evapotranspiration in the groundwater-dependent ecosystem.

2. LITERATURE REVIEW

The LST-based evapotranspiration estimation is valuable in the practical application of water management (Chen, 1999). Luyssaert et al. (2014) discovered the LST variation, not a relationship with wetland change. However, the many studied found wetland changes have an impact on climate at large or mesoscale scales (Lofgren, 1997; Chen et al., 2006; Hu et al., 2009; Song, 2006; Tong and Zheng, 2006; Nie and Wang, 2010) and small scale (Nie and Wang, 2010; Krinner, 2003 and Gao et al., 2002). Wetland vital land cover character to determine of local climate through a cold, humid effect (Nie and Wang, 2010; Krinner, 2003 and Gao et al., 2002). The character of different albedo, heat, capacity, roughness, and energy exchange (Krinner, 2003). Wetland reduces the LST and raises humidity under the condition of intense radiation and evapotranspiration (Gong et al., 2010). Most studies, as mentioned above, relocated at temperate. Studies on wetland land

cover impact to LST at tropical climate lacks in the central literature review. There is a great deal of work to be done in this area, wetland, and LST. During the past 31 years, the rapid development at Kuching. It is necessary to study the wetland's effect on the local climate in this region to provide a strong foundation and knowledge for a future study of the impact of wetland change on the local climate. In this study, thermal band Landsat applied for the year 1988 and 2019. The analyses of change detection between 1988 and 2019 carried out to study the impact of deforestation of wetland and vegetation at area study besides that this study examined LST statistics between the years 1988 and 2019. The finding can enhance knowledge of environmental and climate effects from wetland changes, while at the same time, donating meaningfully to a quantitative understanding of wetlands' ecological functioning.

3. STUDY AREA

Kuching relocated to Borneo, which capital city of the state of Sarawak, Malaysia. The history mentioned that civilization began at surrounding Sungai Sarawak. The main reason for most development surrounding Sungai Sarawak. The region's climate is a tropical rainforest with annual precipitation of 4200 millimeters (Thomas Cook, 2013). The average temperature value of 19 °C to 36 °C (MOSTI, 2014). The Northeast season in September until March and the southeast from May until August. The northeast season's significant wet season at Kuching and the southeast season is dry. In 2018, the Kuching population was 570, 407 (United Nations, 2018). The literature review has recommended focussing on small-medium cities with a population below 2 million (Zhou et al., 2019). The primary motivation of the author to choose Kuching as an area study.

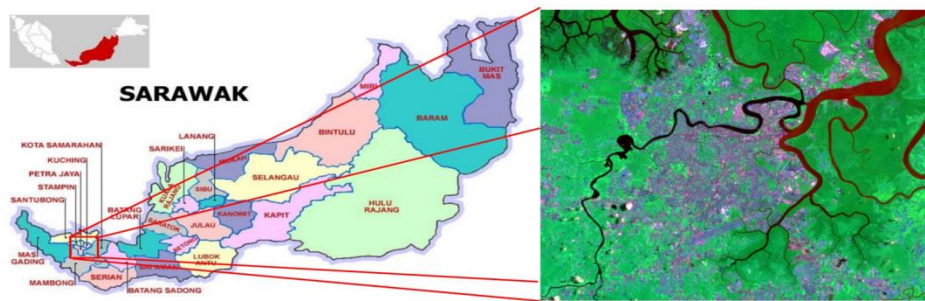


Fig 1. Location of the study area.

4. METHODOLOGY

Table 1: Information of dataset

Sensor	Thermal Band	Resolution (Meter)	Data Acquisition
Landsat 5	Band 6	100	25 May 1988
Landsat 8	Band 10	120	15 May 2019

The band 6 Landsat 5 TM and band 10 of Landsat 8 which utilized in this study. Pre-processing such geometric correction is required to study the change between imagery two data. After that, atmosphere correction and radiometric correction are required before to retrieval of LST from the thermal band.

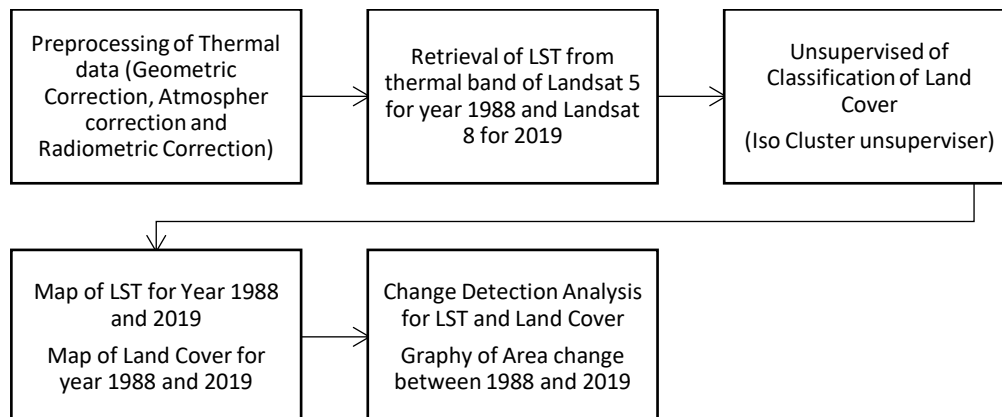
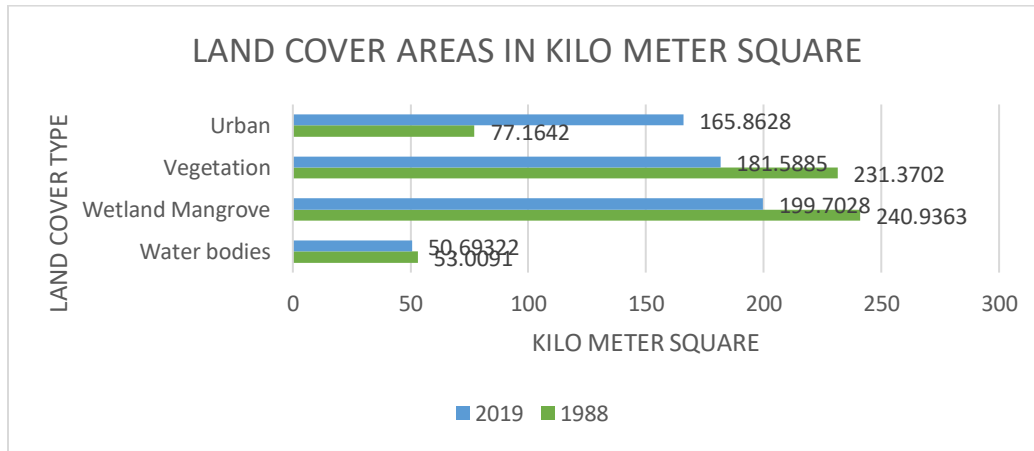


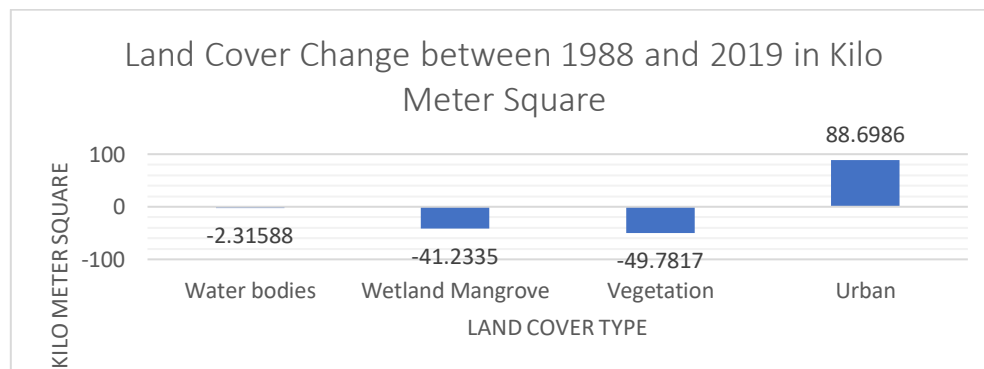
Fig2: Flow methodology

The step of retrieval of land surface temperature at Landsat 5 and Land 8 was applied the based following the step on paper Ricky and Oliver, (2019).

5. RESULT AND DISCUSSION



In the year 1988 shows the area of land cover wetland mangrove is the highest with 240.94 km². The second highest of the area is vegetation land cover with 231.37 following urban area with 77.16 km² and the last water bodies land cover with 53 km². The trend of highest for the year 2019 was similar to 1988 with wetland 199.70 km², other vegetation with 181.58 km² and third urban area with 165.86 km² and lastly water bodies with 50.69 km².



The most significant change between land cover for the years 1988 and 2019 is an urban with an increase of 88.69 km². The urbanization replaces wetland mangrove at the area at Sama Jaya Free Industrial Zone, Pending Industrial Estate, DemakLaut Industrial Phase 1,2, and 3. The water bodies to build up, namely at Sama Jaya Port and Kuching Port. The next transformation from vegetation to build up human for settlement at Tabuan Height, Kota Sentosa, TabuanDesa, Petra Jaya, and Kampung Rampangi. The second biggest land cover change of vegetation decrease from 49.78 km² and following wetland mangrove with 41.23 km² and lastly water bodies with 2.31 km².

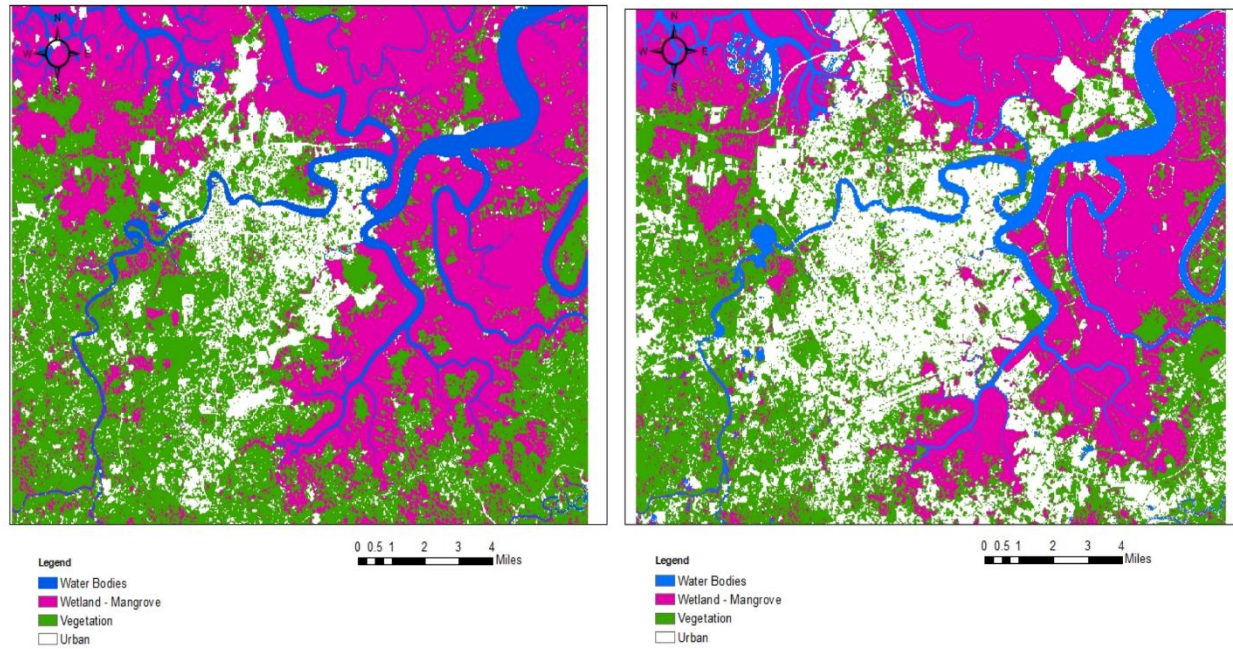


Fig 2. Land cover map of the year 1988 (Left) and Land cover map of the year 2019 (right).

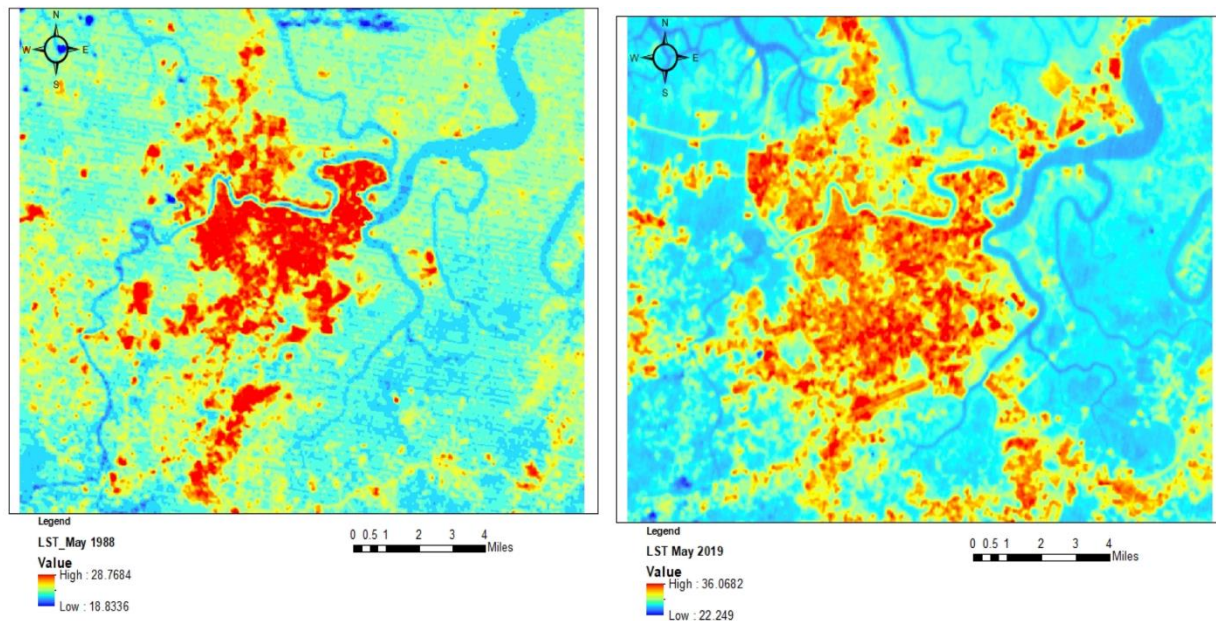


Fig 3. LST map of the year 1988 (Left) and LST map of the year 2019 (right).

The above shows the map of LST for the years 1988 and 2019. The maps show the increase of the Surface urban heat effect island (SUHI) pattern from 1988 and 2019. The SUHI pattern increase from the center of the city to the suburban area. The increase of SUHI significantly increase the LST statistics as mentioned in the table below: The min of LST in 1988 with value 18.83 increased to 22.24, and following the max of value LST 28.76 in 1988 rose to 36.06 in 2019. The data mean of LST also increases from 23.00 to 26.64. The increase in data statistics because of influence growing the SUHI at area study. The transformation from natural areas to build up a significant rise in LST surrounding area study. The data was captured both in May, which was no significantly influenced by the monsoon season.

Table 2: Data statistics of LST for the year 1988 and 2019

Data statistics	The year 1988	The year 2019
	Value (Degree Celsius)	Value (Degree Celsius)
Min of LST	18.83	22.24
Max of LST	28.76	36.06
Mean of LST	23.00	26.64

Table 3: Data statistics of LST for the years 1988 and 2019

Data statistics	The year 1988	The year 2019
	Value (Degree Celsius)	Value (Degree Celsius)
Mean of LST at Urban Areas	26.83	33.24
Mean of LST at Vegetation Areas	22.54	26.78
Mean of LST at Water bodies	21.20	25.93
Mean of LST at Wetland - Mangrove	22.40	26.20

. The chart above shows the mean of LST at every mainland cover at area study. The urban areas value highest is 26.83 and 33.24 for the year 1988 and 2019, following means of LST at vegetation areas 22.54 for the year 1988, 26.78 for the year 2019. The wetland mangrove for a mean of LST at 1988 22.40 and increase in 2019 with value 26.20. The lowest is water bodies with 21.20 for the year 1988 and 25.93 for the year 2019. Transformation of from nature to build up building was the modification of surface properties cause to more absorption of solar radiation, reduce convective cooling, and lower water evaporation rates. Because of this, the LST at urban higher than vegetation and water bodies (Gunawardena et al., 2017).

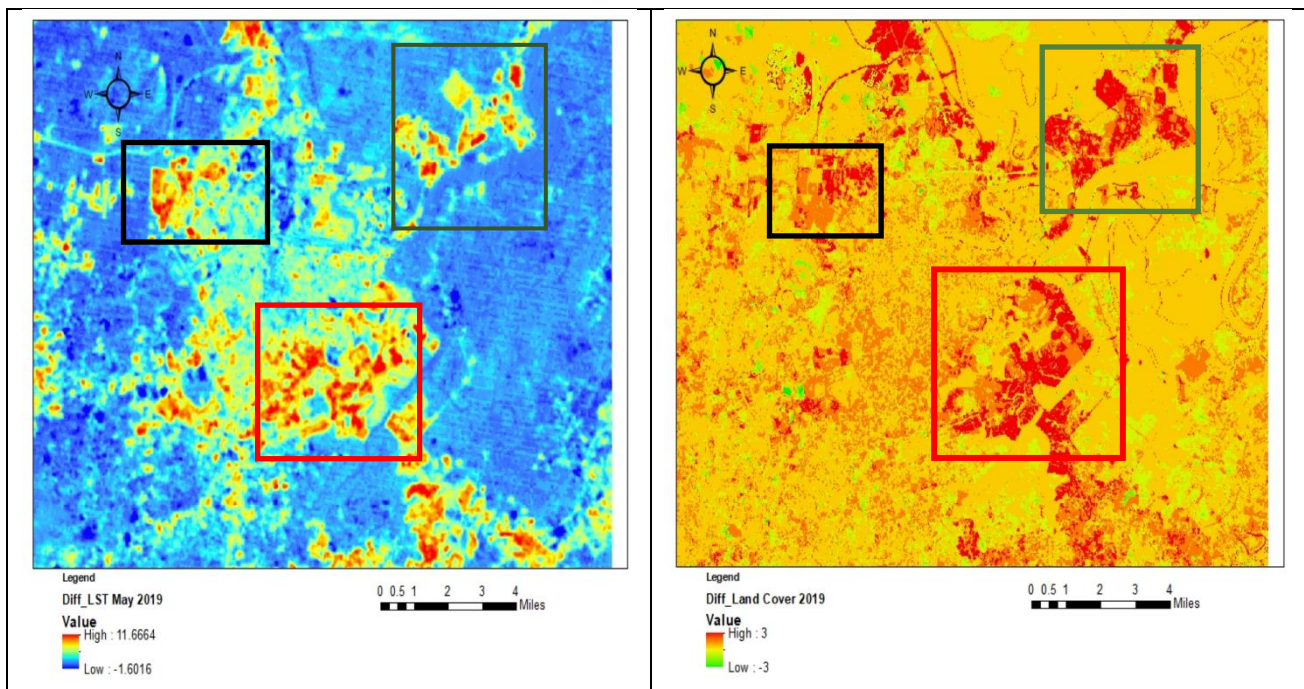
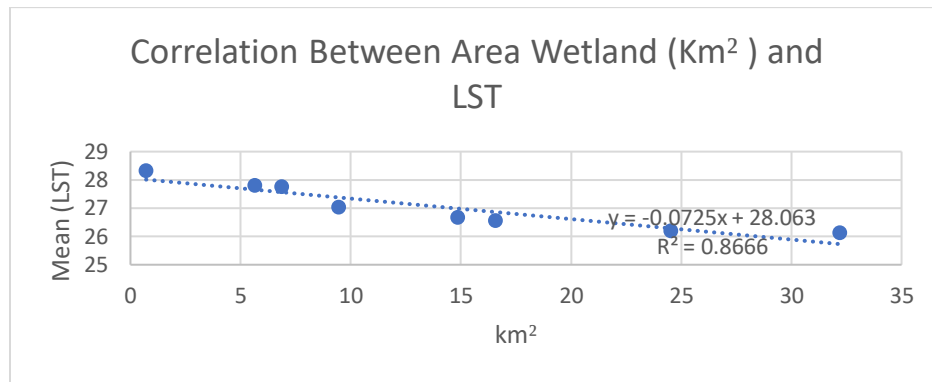


Figure 3: Map of change between LST for the year 1988 and 2019 (left) map of change detect for land cover for the year 1988 and 2019 (right). The square white in the year 1988 was a wetland, and vegetation converts to settlement at Tabuan Baru, Riveria, and kampung Stutong. The red square relocated at Sama Jaya Free Zone Industrial, Muara Tabuan Light Industrial park, and Pending Industrial Estate. The wetland mangrove has been destroyed and replaces with build up such industrial area and Port. The green square relocated at Demak Industrial Park Phase 1, 2, and 3. At here, relocate of Power Plant Sejingkat and settlement of Senari, Sejingkat, and Muara Tebas. The more significant change in this area, which previous in 1988, the most place contains vegetation and wetland mangrove. The last, which black square relocated to Kampung Semerah Padi Matang, Petra Jaya, and Kampung Rampangi (settlement). The most of land cover in the area here in 1988 is vegetation, and wetland is transformed into the settlement. The change of land cover from vegetation and wetland to urban / built area significant increase of LST.



There was a strong negative correlation observed between area km² with LST with R² 0.866. The most significant area of wetland contributes to the lowest of LST than a small area of wetland. The vital wetland characteristics in reducing the local climate. Because of the function of high evapotranspiration in the wetland to reducing of LST. The temperature of LST increases 1-degree Celcius for every five km² reclamations of wetland.

6. CONCLUSION

Wetland and vegetation are vital components to determine the local climate. The decrease in the quantity of wetland and vegetation significantly increase of LST. The technology of remote sensing now a practical way to detect the thermal environment of a wetland and its surrounding area. Besides that, remote sensing technology to study the impact of land cover change to LST on a more extensive and local scale. Besides that, GIS technology offers to study the impacts of wetland deforestation on local temperatures at a local scale. The result shows the correlation between the size area of wetland and LST. Every 5-kilometer square (km²) wetland lost an increase in 1-degree Celsius of LST. The size area of wetland influence on LST was significant. Wetland is a critical component in the earth's surface in reducing urban heat effects and climate change.

ACKNOWLEDGMENT

Thank NASA policy, which because gives free access to data of Landsat generation.

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