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Effects of Land use/Land Cover Change on Surface Urban Heat Island Intensity in Phnom Penh

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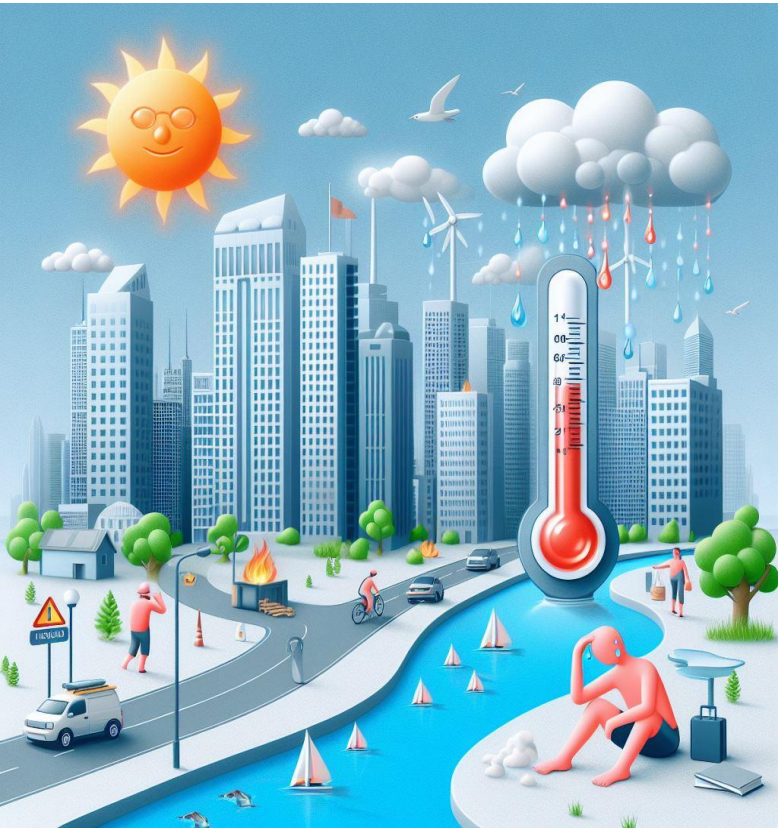
Problem Statements

What would happen if the city becomes hotter?



- **Urban heat island effect**
- **Health risks**
- **Energy demand**
- **Water scarcity**
- **Air quality**
- **Infrastructure stress**
- **Ecosystem disruption**

Objectives

Generate land use/land cover and land surface temperature map using remote sensing technique

Study the effects of land use/land cover change on land surface temperature and surface urban heat island intensity

Site Description and Data collection

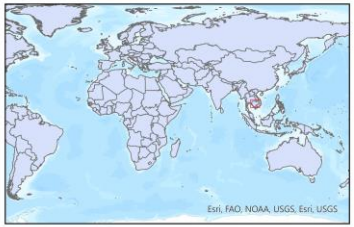
Phnom Penh capital:

- Area: 684 km²
- Population: 2.3 millions citizens (2023)
- Population density: 5700/km² (2023)
- Dry season: (December to May)
- Rainy season: (June to November)
- Temperature: minimum 18°C to maximum 35°C

- **All dataset were collected from open access data such as U.S. Geological Survey (USGS) and Copernicus**

Date	Satellite	Scene Center Time	Cloud (%)
20/08/2015	Sentinel 2	03:15:36.027Z	26.74
22/03/2019	Sentinel 2	03:15:41.024Z	4.27
06/03/2023	Sentinel 2	03:16:19.025Z	0.89
16/02/2015	Landsat 8	03:19:50.0454310Z	4.46
15/03/2019	Landsat 8	03:19:37.2123530Z	5.24
10/03/2023	Landsat 8	03:20:00.2980310Z	8.17

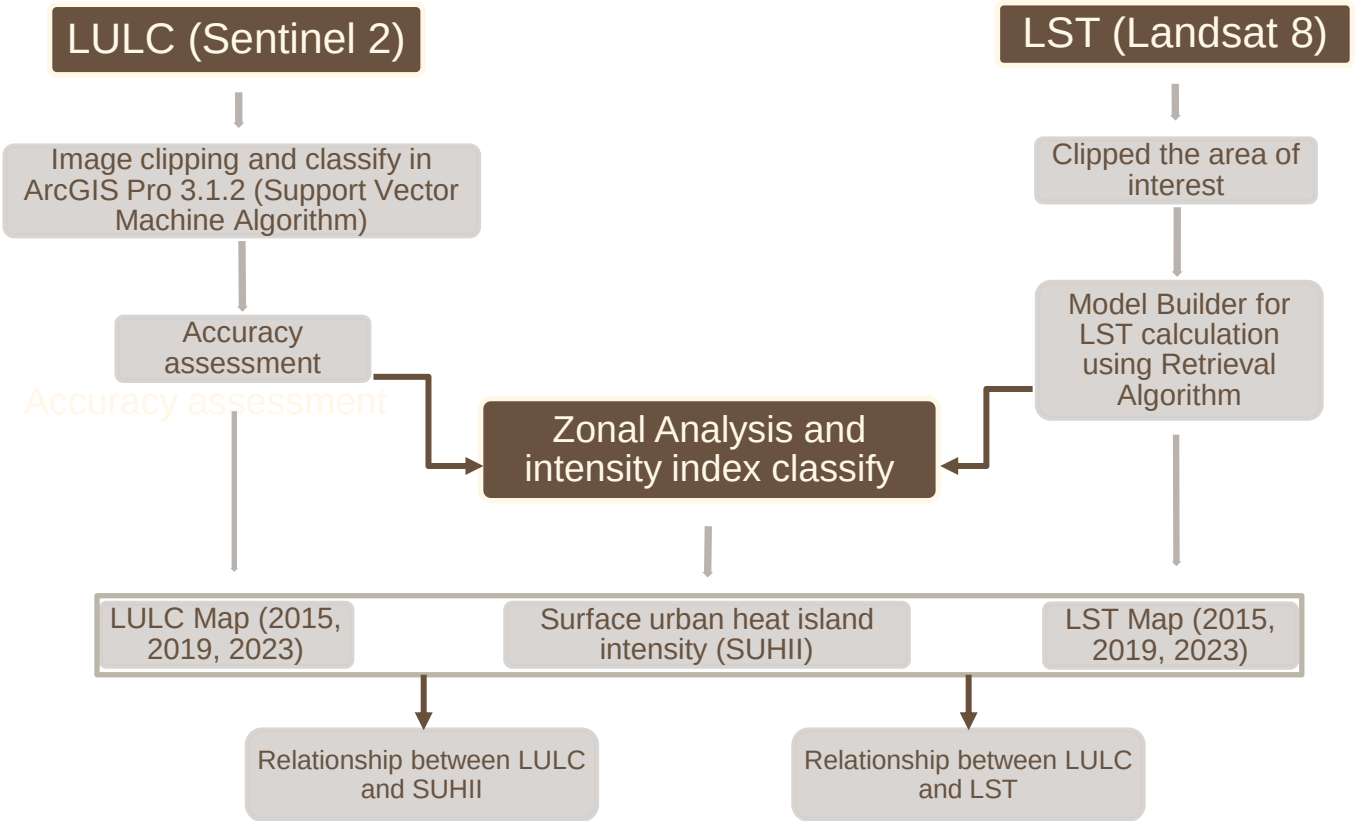
Phnom Penh from Sentinel 2 satellite, 20th August 2015



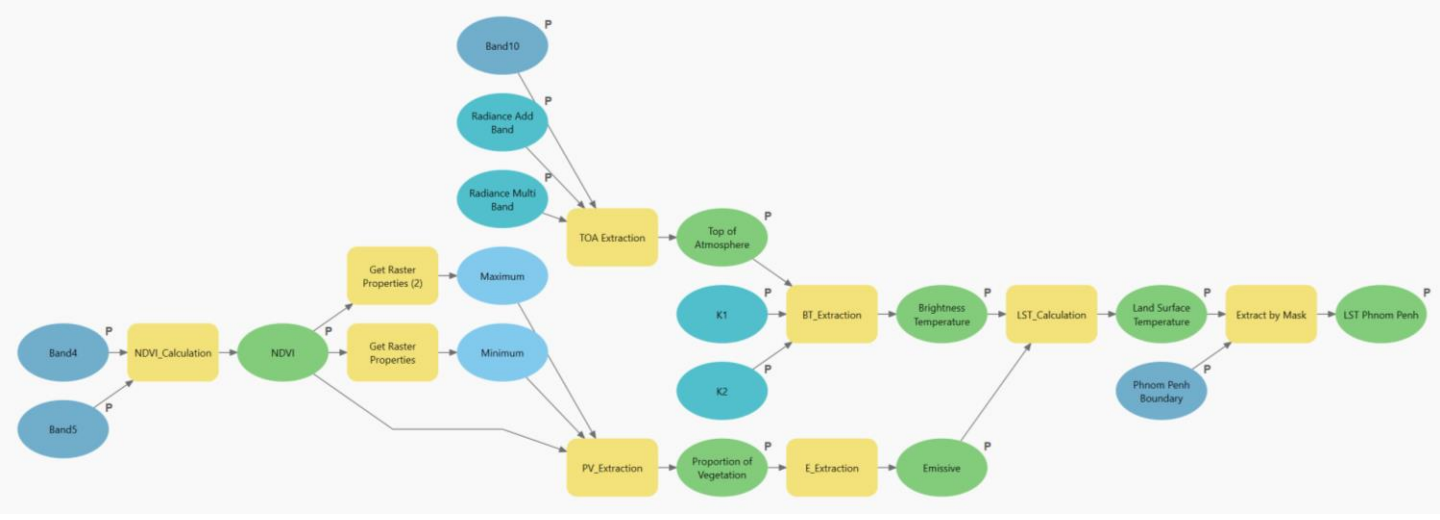
5 classes of LULC were classified

Class	Definition	Image
Water	Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrop nor built up features like docks; examples: rivers, ponds, lakes, oceans, flooded salt plains.	
Built-up areas	Human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages / towns / cities, paved roads, asphalt.	
Bare ground	Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and sand dunes, dry salt flats/pans, dried lake beds, mines.	
Green areas	Land that is significantly covered by vegetation. This can include: Trees, Flooded vegetation, and urban green space.	
Agricultural land	Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, rice fields, soy, fallow plots of structured land.	

Research flow chart



Model Builder for LST calculation using Retrieval Algorithm



Use Band (4, 5, 10) for Landsat8

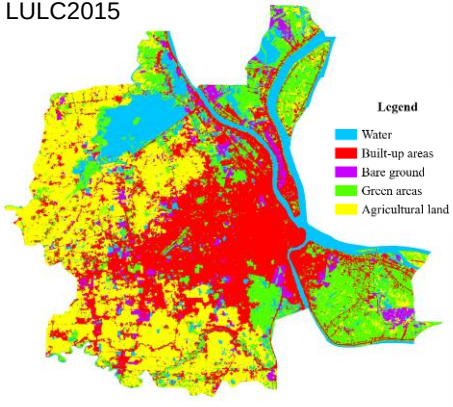
Accuracy assessment results

Year	Overall ACC	Kappa Coef.	Producer's ACC					User's ACC				
			Water	Built-up areas	Bare ground	Green areas	Agricultural land	Water	Built-up areas	Bare ground	Green areas	Agricultural land
2015	92%	0.89	96%	96%	74%	87%	95%	93%	88%	94%	98%	96%
2019	91%	0.88	97%	98%	85%	84%	86%	97%	86%	94%	93%	94%
2023	93%	0.90	93%	96%	86%	89%	91%	93%	95%	95%	91%	89%

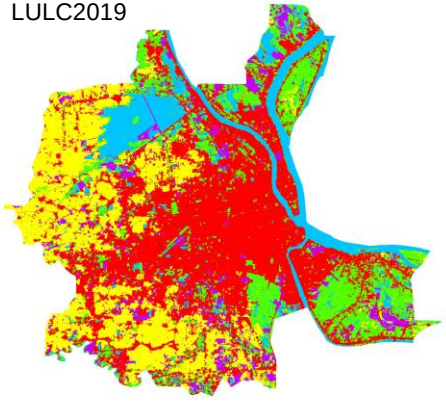
- According to Monserud and Leemans (1992) the degree of agreement is excellent when the value of accuracy is range from 0.85 to 0.99
- The overall accuracy assessment of each year is reliable which they are 92%, 91% and 93% in 2015, 2019, 2023 respectively

Land Use/Land Cover Maps (2015-2023)

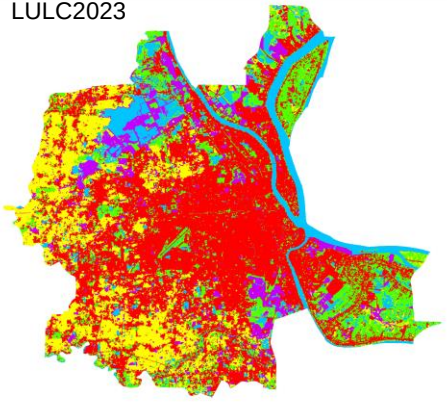
LULC2015



LULC2019



LULC2023

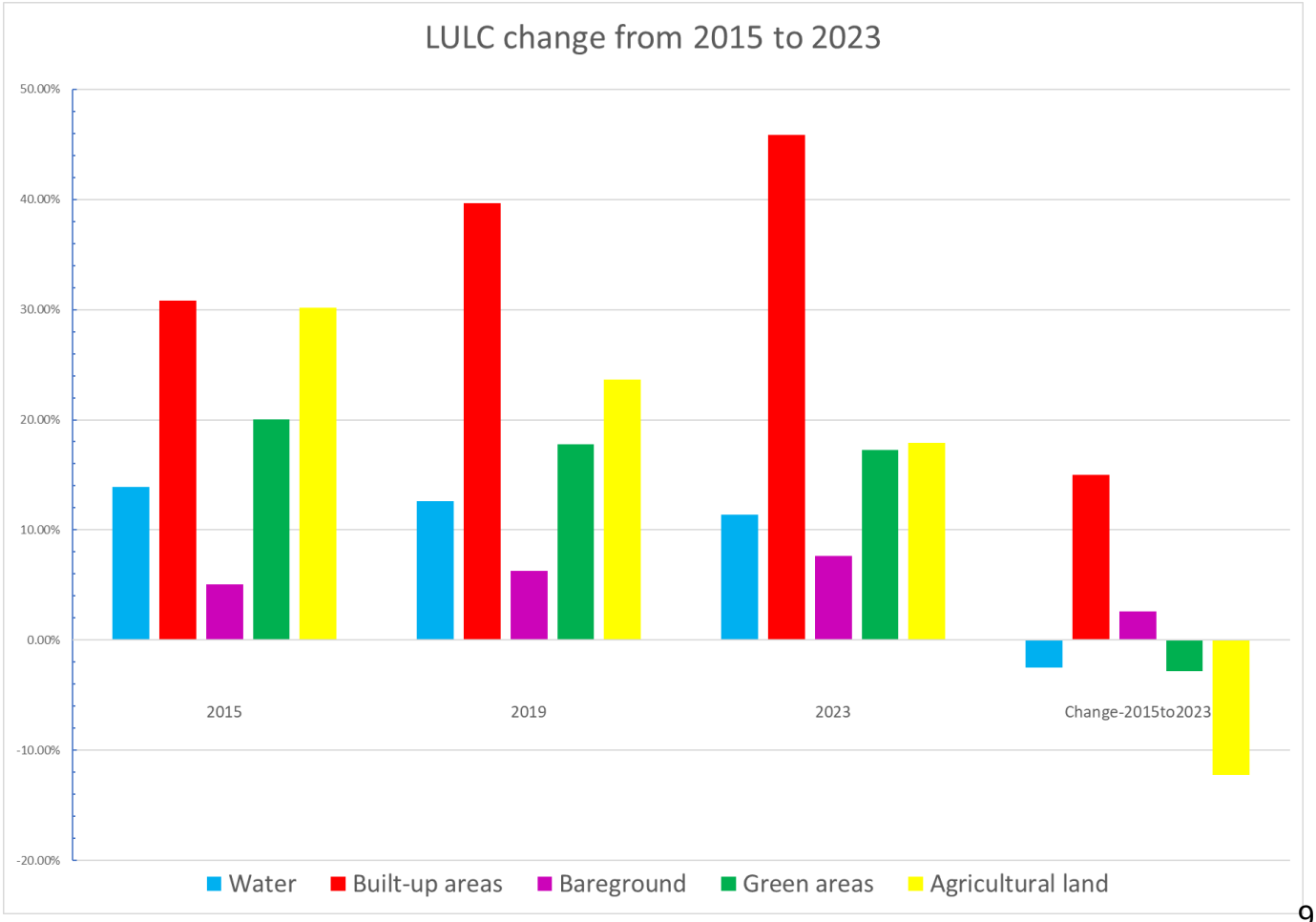


2015 True color image from sentinel 2

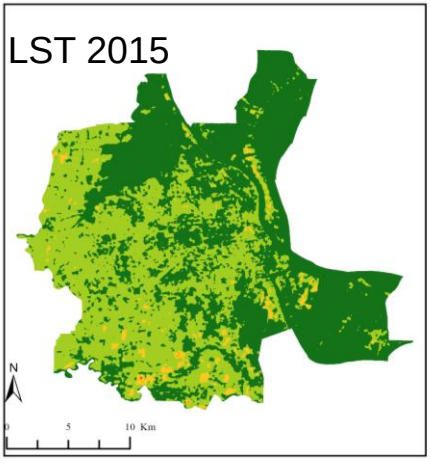
2019 True color image from sentinel 2

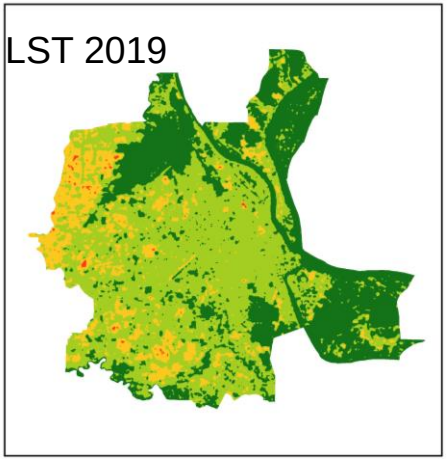
2023 True color image from sentinel 2

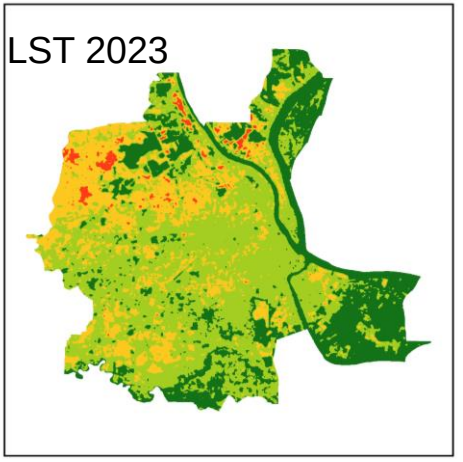
3. Results and discussion (Cont.)

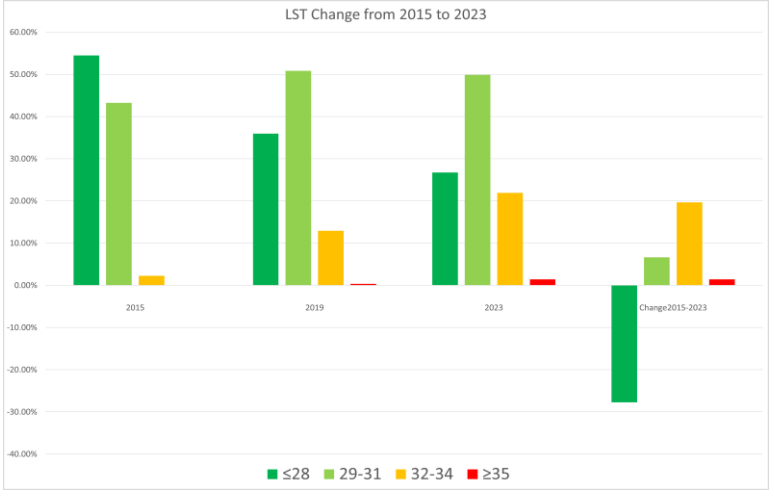


Land Surface Temperature Maps (2015-2023)







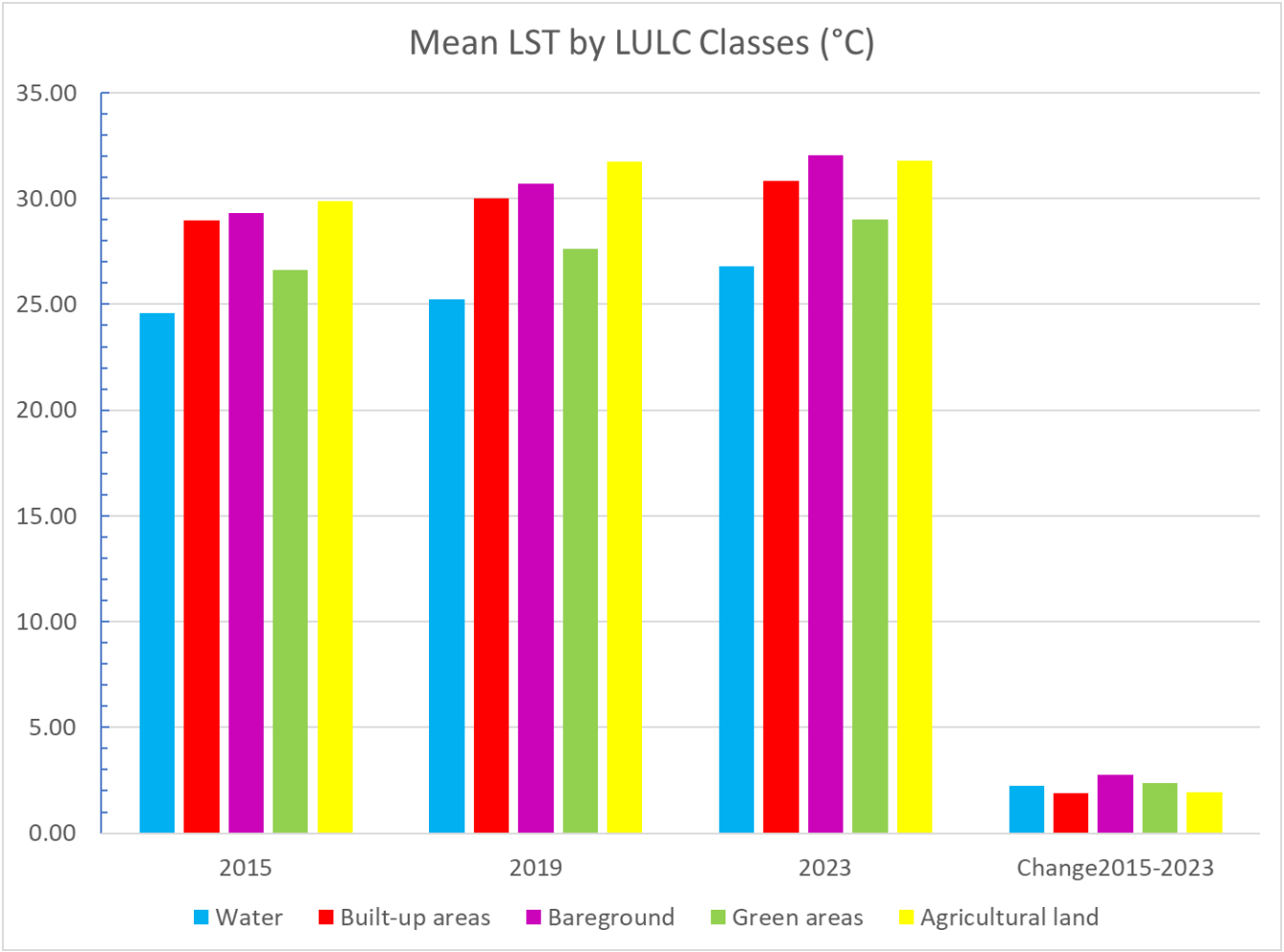


Class (°C)	2015	2019	2023	Change2015-2023
≤28	54.50%	35.94%	26.76%	-27.74%
29-31	43.24%	50.81%	49.90%	6.66%
32-34	2.25%	12.90%	21.91%	19.67%
≥35	0.01%	0.35%	1.43%	1.41%

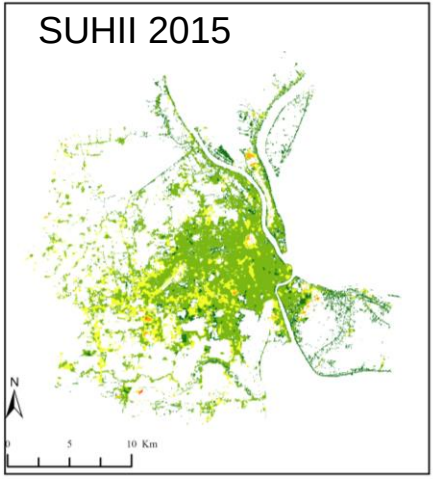
Overall LST Statistic (°C)

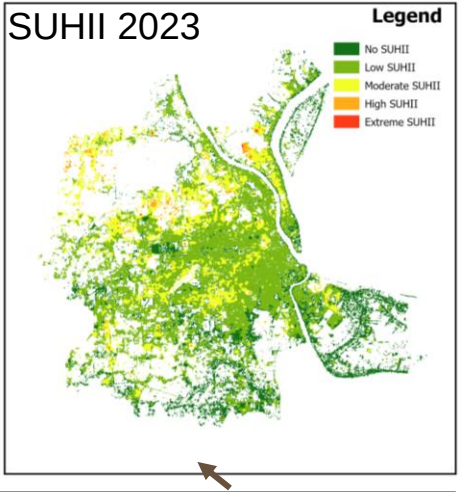
Year	2015	2019	2023	Change2015-2023
Min	22.56	23.62	24.34	1.79
Mean	28.17	29.44	30.33	2.16
Max	35.49	37.28	37.56	2.07

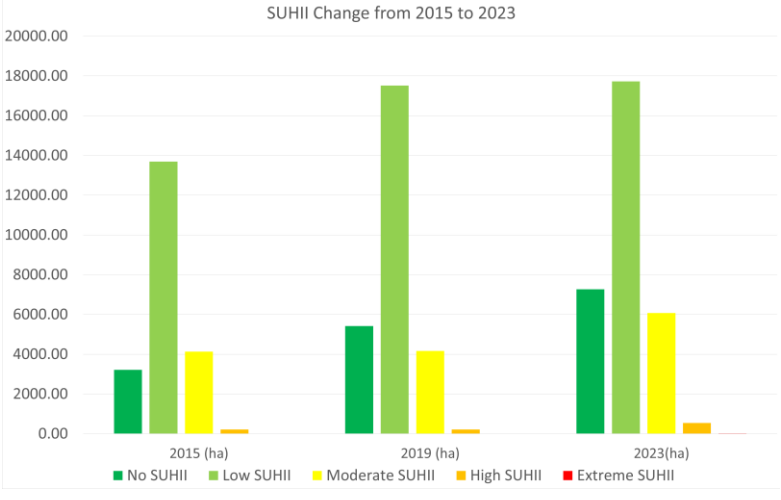
3. Results and discussion (Cont.)



3. Results and discussion (Cont.)







SUHII= $LST_{Built\ up}$- $LST_{Non-built\ up}$

SUHII Levels

SUHII	Levels
<0	No SUHII
0-2	Low SUHII
2-4	Moderate SUHII
4-6	High SUHII
>6	Extreme SUHII

Analysis of SUHII

Year	Mean (°C)		
	Non built up areas	Built-up areas	SUHII
2015	27.83	28.95	1.12
2019	29.07	29.99	0.92
2023	29.90	30.84	0.93
Change2015-2023	2.08	1.89	-0.19

4. Conclusion and recommendation

Conclusion:

- The open remote sensing data can be used to observe and study the effects of LULC change on SUHII
- While the green areas, water and crops decreased, the built-up areas and bare ground increased especially the built-up areas increased from 30.82% in 2015 to 45.83% in 2023
- The LST on bare ground, crops, and built-up areas are higher than water and green areas
- The areas of highest LST (≥35 °C) slightly increased from 0.01% in 2015 to 1.41% in 2023 while the lowest LST (≤28 °C) repeatedly decreased from 54.50% in 2015 to 26.76% in 2023
- The lower SUHII mostly is surrounded by water and green areas, but the higher SUHII is surrounded by bare ground and agricultural land
- Built-up areas have higher mean LST than non-built areas, but the LST on the non-built up increase more quickly than the built up, which could cause the SUHII to drop from 1.12 °C in 2015 to 0.93 °C in 2023 even the built up areas is increased repeatedly

Recommendation:

- Preserve the green areas and water, and if feasible, designate urban green and blue space to reduce city temperatures.
- Residents should prefer to live close to a body of water, such as a lake or river, and leave some spaces in their homes for gardens.
- For the future studies, the building's height should be the variable for the effects of LULC changes on SUHII

Thank you for your attention

Q&A?