Assessing the cooling effect of urban vegetation in Perth Metropolitan Region

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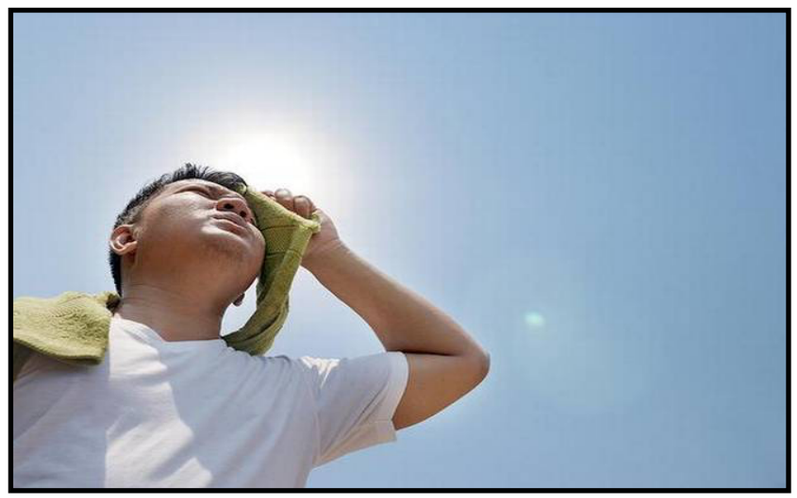
Introduction

1 Statement of the problem.

- Growing population.
- Landcover change due to urbanization.
- Heat stress on population.



2 How can this problem be mitigated?

- Re-vegetation / preserving vegetation.
- Reduces temperature due to shading and evapotranspiration (Rosenzweig et al., 2006).
- 10% increase can reduce 1^{o}C. (Duncan et al., 2019)

3 Aims and objectives

Assess the cooling effects associated with vegetation and sustainable development strategies at three urban location across the Perth Metropolitan Region, Western Australia using SOLWEIG model.

This aim was achieved through addressing the following objectives:

1. Predict landcover at two time-steps during urban development using a machine learning classification approach in Google Earth Engine, multispectral imagery and associated surface models.
2. Estimate variation in temperature (mean radiant temperature and land surface temperature) using SOLWEIG model (component of UMEP toolkit in QGIS).
3. Assess the performance of SOLWEIG model in predicting LST by comparing SOLWEIG predictions with Landsat 8 LST observations.

Methodology - Overview

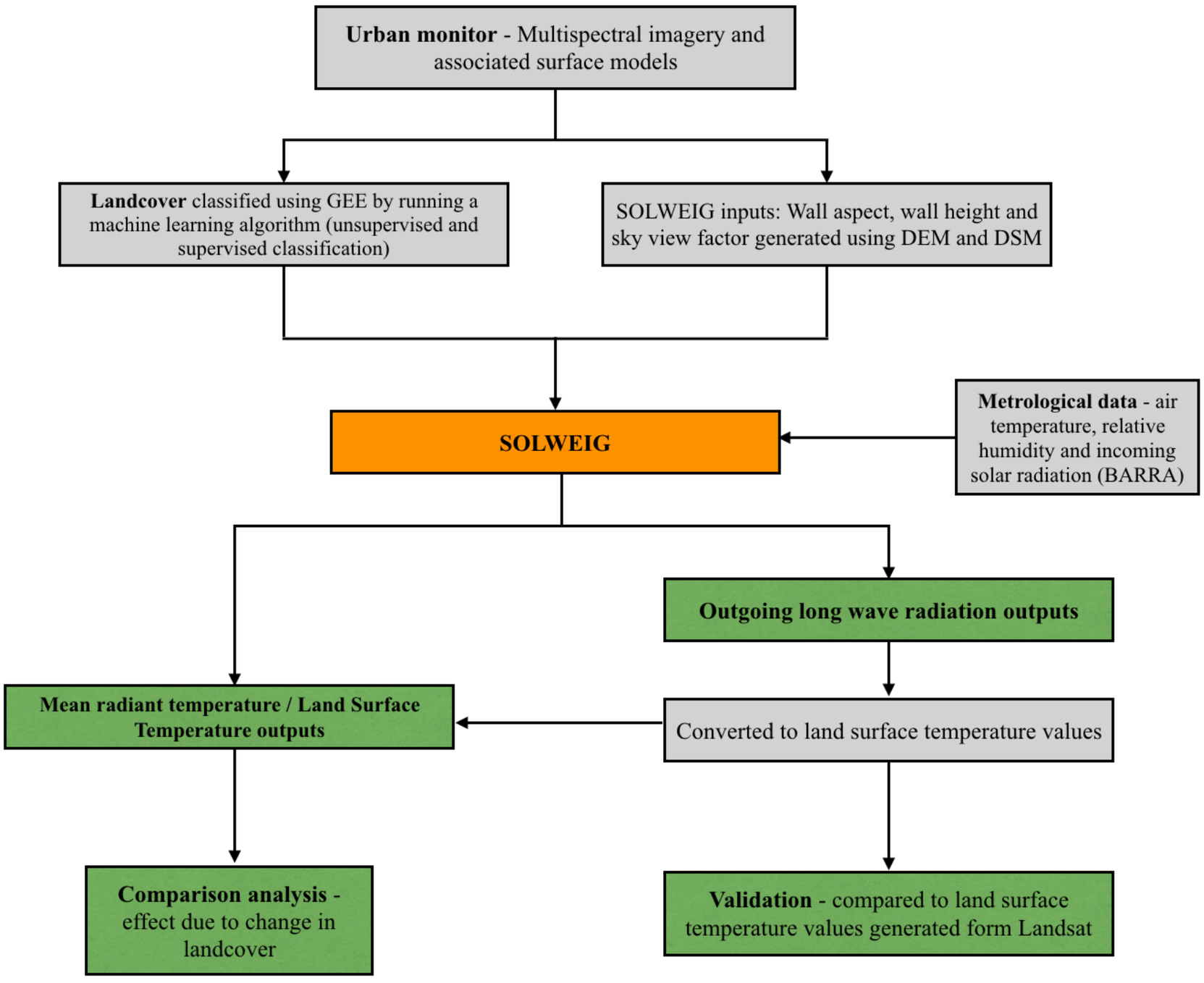


Figure 4: Data processing workflow.

Results - Landcover classification

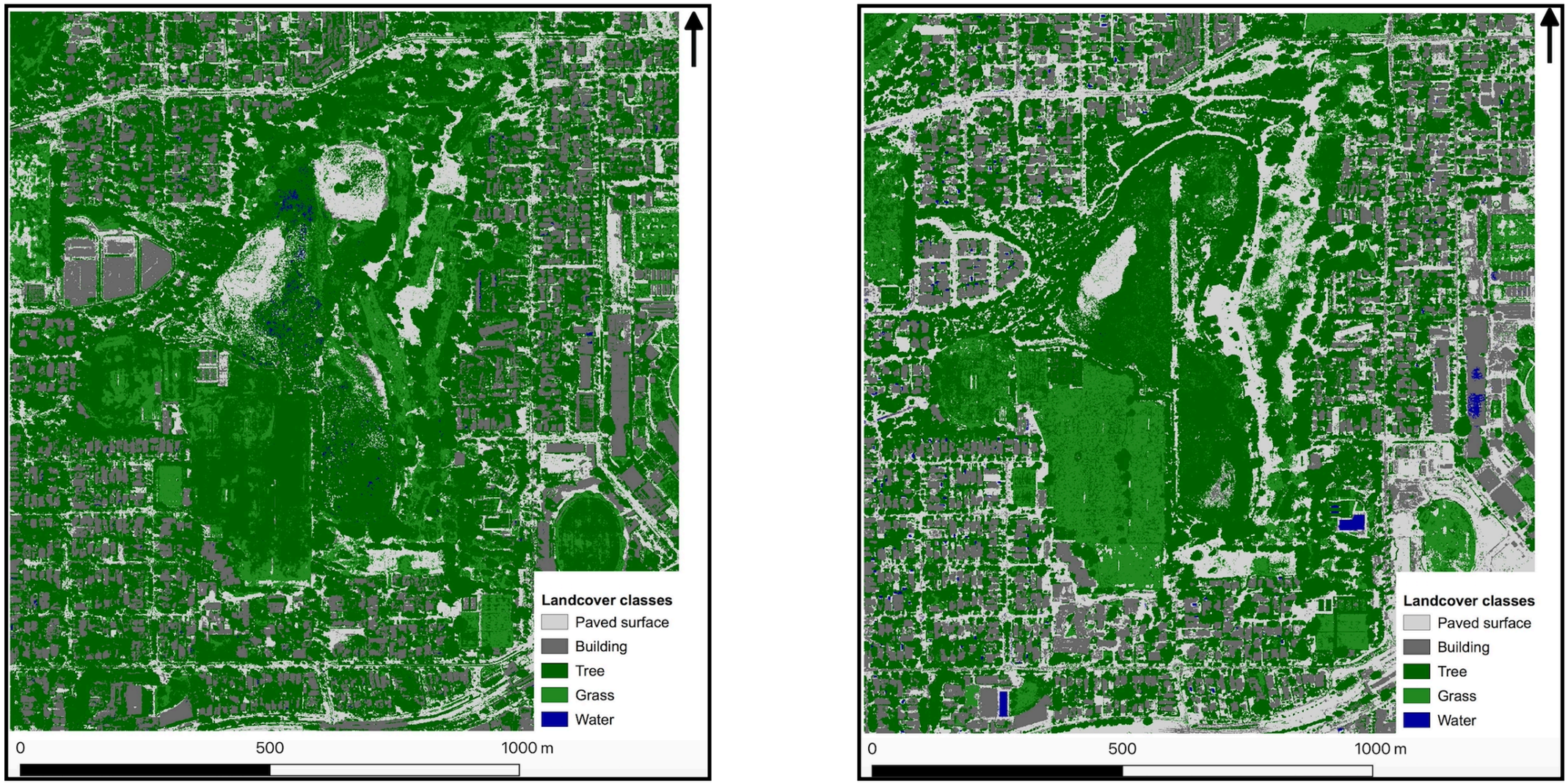


Figure 5: Landcover classification of Lake Claremont 2009 (left) and 2016 (right).

Study area & resolution	Accuracy	Kappa value
Lake Claremont (2009) – 1 m	0.82	0.67

Study area & resolution	Accuracy	Kappa value
Lake Claremont (2016) – 1 m	0.73	0.55

Results - Landcover classification

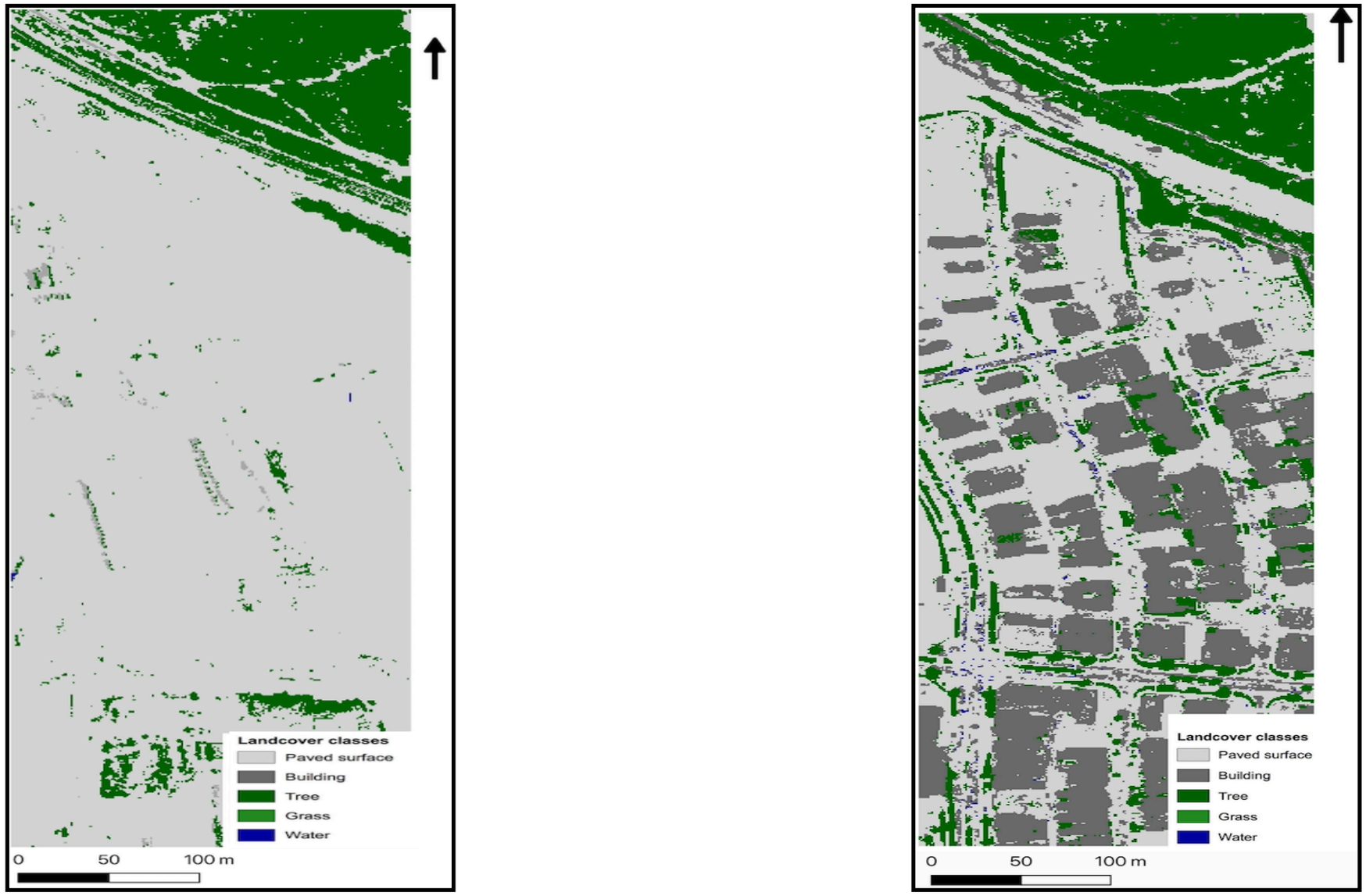
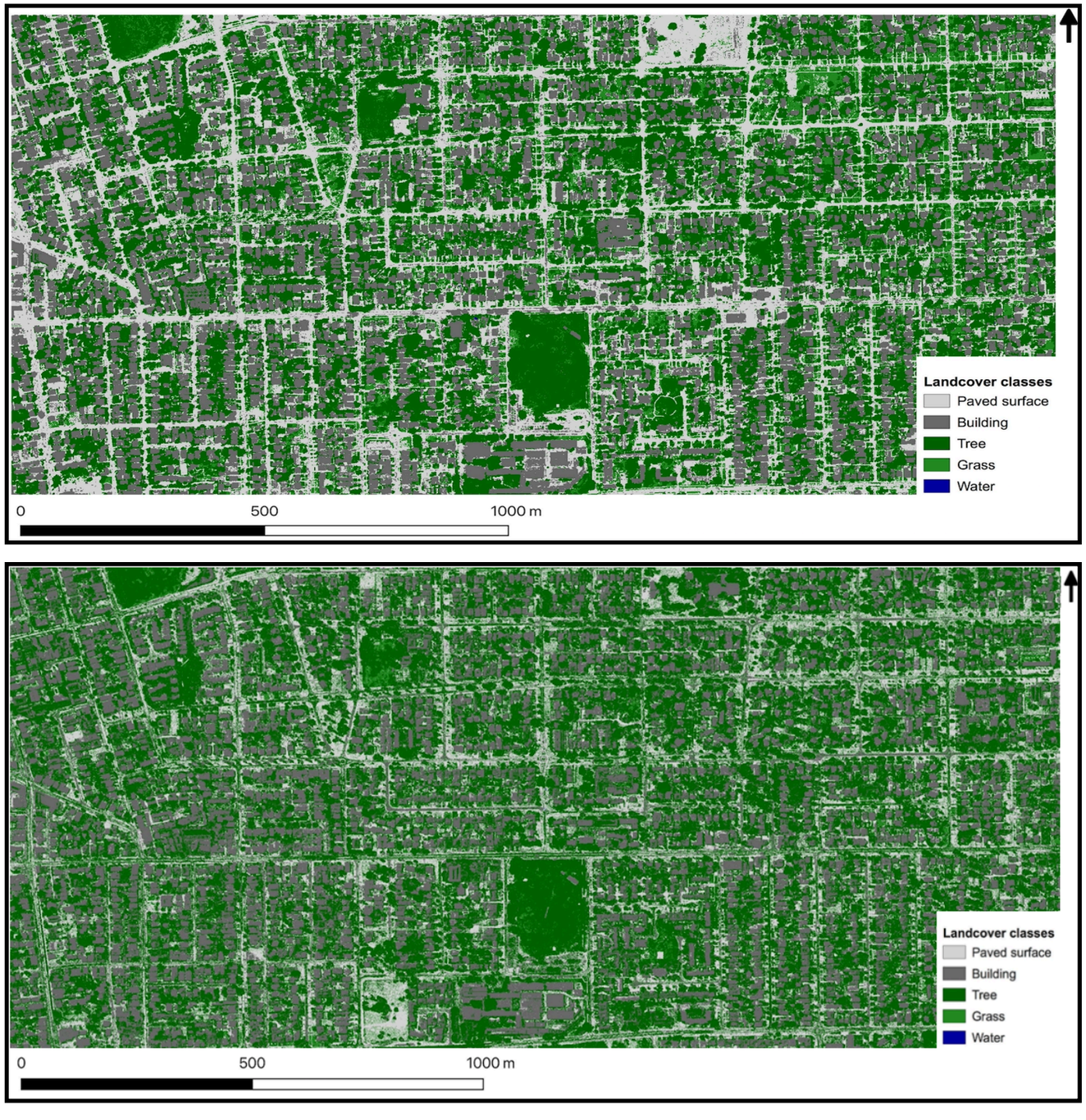


Figure 6: Landcover classification of Port Coogee 2009 (left) and 2016 (right).

Study area & resolution	Accuracy	Kappa value
Port Coogee (2009) – 1 m	0.88	0.80

Study area & resolution	Accuracy	Kappa value
Port Coogee (2016) – 1 m	0.79	0.69

Results - Landcover classification



Study area & resolution	Accuracy	Kappa value
White gum valley (2009) – 1 m	0.84	0.70

Study area & resolution	Accuracy	Kappa value
White gum valley (2016) – 1 m	0.81	0.69

Figure 7: Landcover classification of White Gum Valley 2009 (up) and 2016 (down).

Results - Model Validation

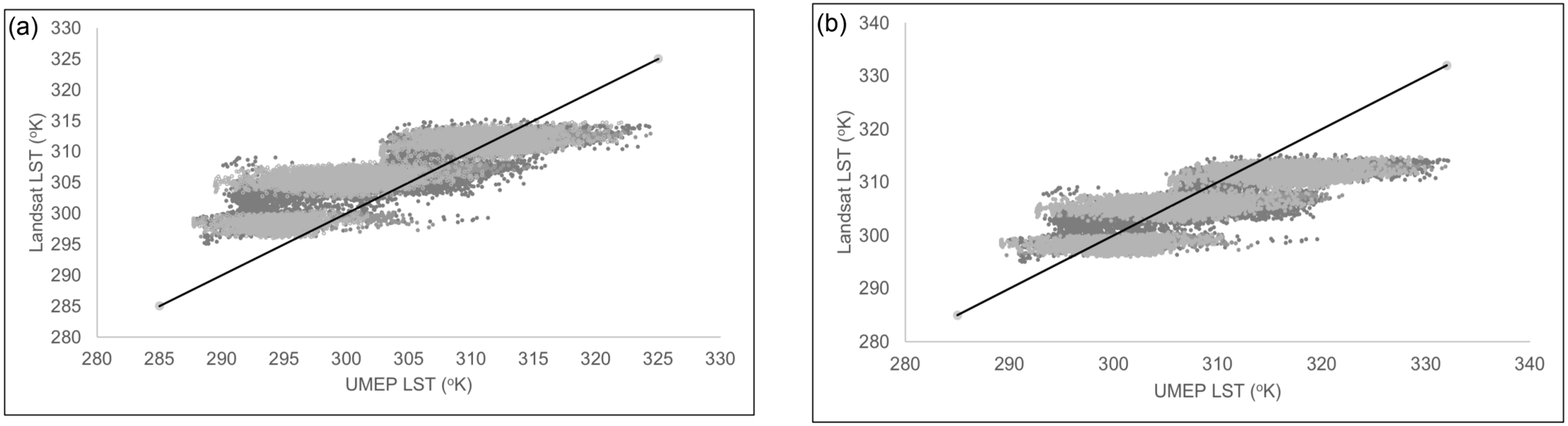


Figure 9: Representation of Landsat LST (Observed) and UMEP LST (Predicted) validation data of Lake Claremont results, Port Coogee and White Gum Valley at 09:30 am (a) 10:30 am (b).

Table 1: Summary of regression model accuracy values

Location	Time	R^2	RMSE	MAE
Lake Claremont	9:30	0.70	5.09	4.13
	10:30	0.65	5.63	4.44
Port Coogee	9:30	0.69	4.48	3.59
	10:30	0.64	9.49	8.81
White Gum Valley	9:30	0.77	5.15	4.23
	10:30	0.72	4.81	3.83

Results - Effect of landcover change

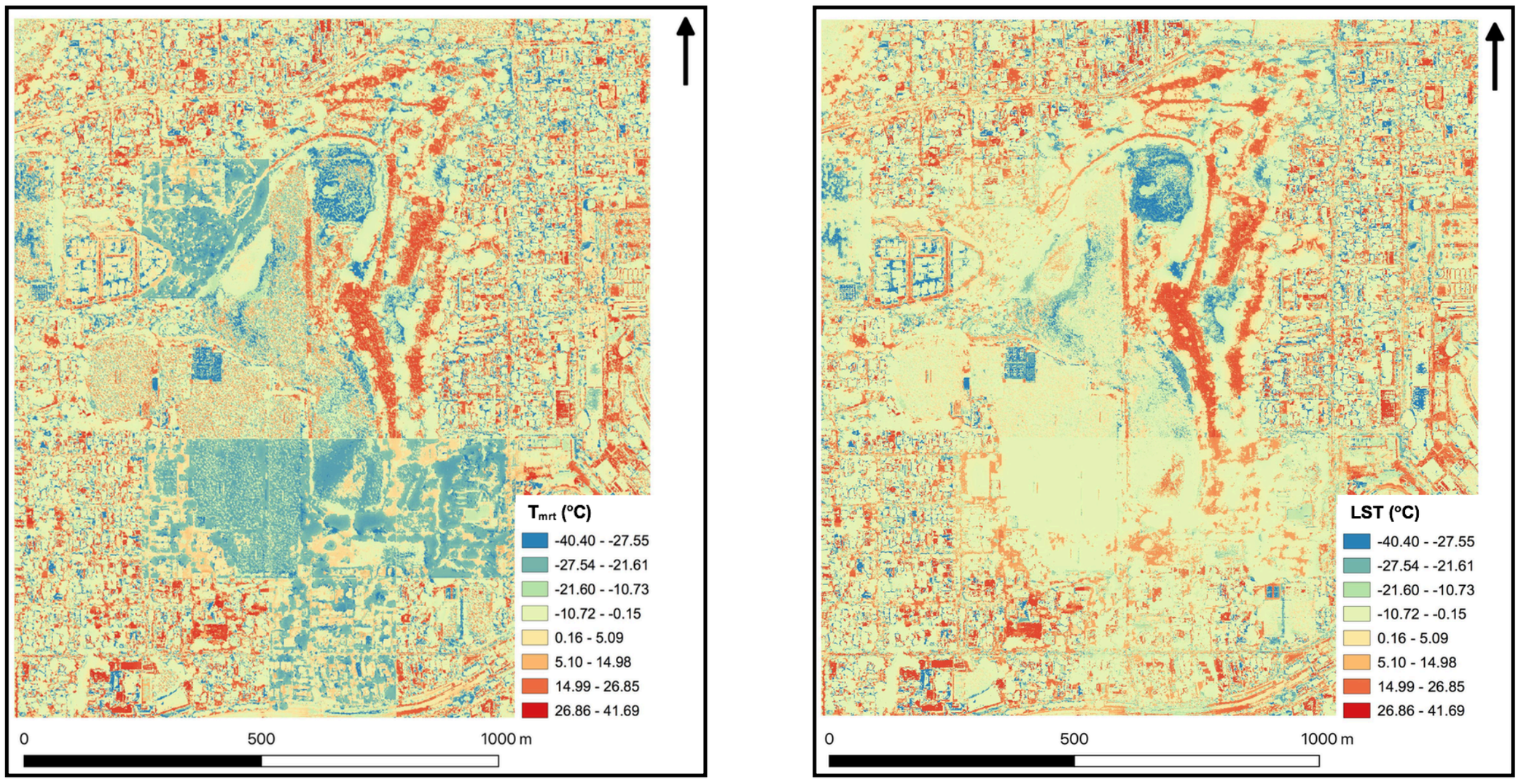


Figure 10: Effect of landcover change on T_{mrt} (left) and LST (right) at Lake Claremont between 2009 - 2016.

Results - Effect of landcover change

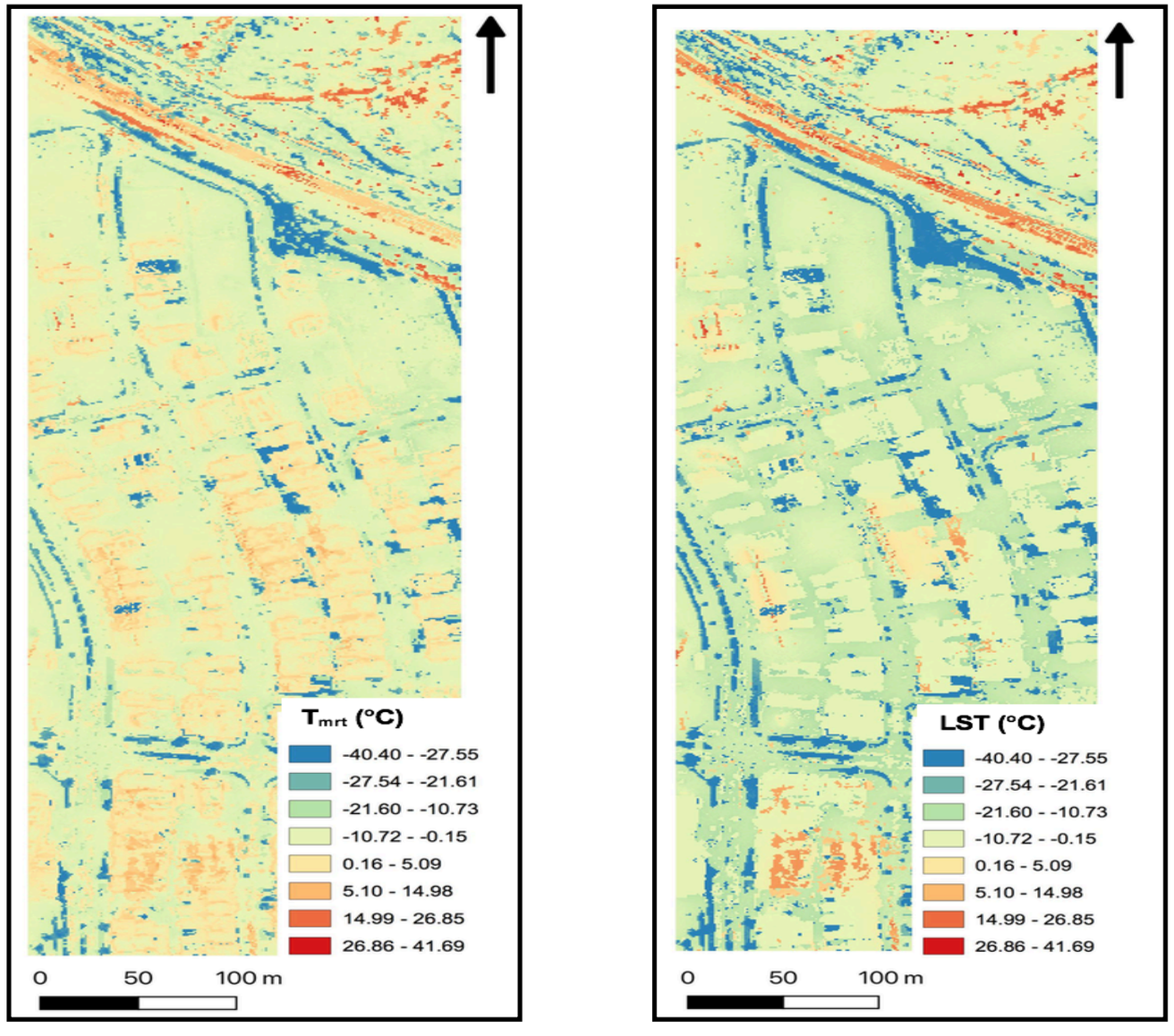


Figure 11: Effect of landcover change on T_{mrt} (left) and LST (right) at Port Coogee between 2009 - 2016.

Results - Effect of landcover change

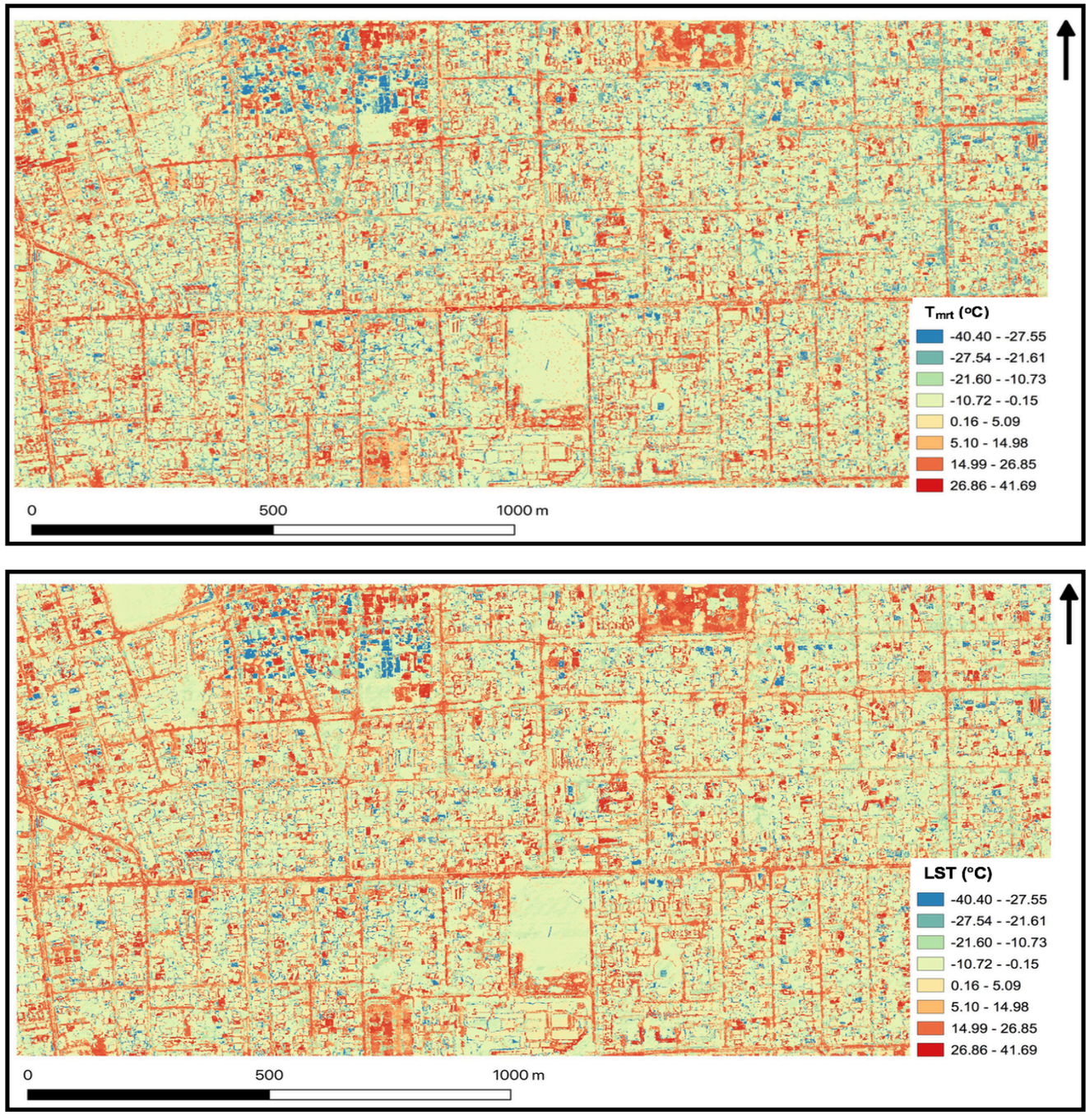


Figure 12: Effect of landcover change on T_{mrt} (left) and LST(right) at White Gum Valley between 2009 - 2016.

Conclusion

- Due to climate change there is going to be increased heatwaves experience by Australian Cities (IPCC, 2014).
- Urban areas already experiencing heat from UHI effects, upcoming climatic changes will be problematic for urban settings.
- More people are living in urban areas, as a result more people will be exposed to thermally stressed urban environments.
- Urban planners need to strategically incorporate revegetation strategies in to current urban geometry to reduce heat stress.
- SOLWEIG was successfully used as an effective model to assess the benefits of vegetation cover.
- This can help support decision-makers when planning new or existing urban environments.
- Although the model holds some limitations it still provides a comprehensive understanding of land cover change on HTC.

Reference

- Duncan, J.M.A., Boruff, B., Saunders, A., Sun, Q., Hurley, J., and Amati, M., 2019. Turning down the heat: An enhanced understanding of the relationship between urban vegetation and surface temperature at the city scale. Science of the Total Environment, 656:118–128.
- IPCC, 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
- Rosenzweig, C., Solecki, W., Parshall, L., Gaffin, S., Lynn, B., and Goldberg, R., 2006. Mitigating New York City's heat island with urban forestry, living roofs, and light surfaces. In Paper presented at the Proceedings of the sixth symposium on the urban environment Atlanta, GA, USA.

Thank you