Quantifying the effect of urban agglomerations on coastal sea surface temperatures

Alexander Plakias, Galina Churkina, and Sebastian Schubert
TU Berlin, Institute of Ecology, Urban Ecosystem Science, Germany

Introduction

Oceans as sink
- 90 % of earth's increasing heat is stored in oceans [1,2]
- Temperature rise amplifies negative feedback loops [3]
  - CO2 uptake → acidification [4]
  - Melting Ice Cover → reduced albedo

High coastal Urbanization
- majority of mega cities located at coasts
- coastal population predicted to rise [5]

Urban Heat Island
- Urban environment experiences higher temperature than rural surroundings [6]
- Temperature rise in many urban agglomerations exceeds 1.5 °C [7]
- Highly studied subject but limited large scale studies[8]

Is accumulated urban heat transferred to water bodies?
- Case studies on streams and lakes [9-11]
- Initial study on localised coastal warming [12]

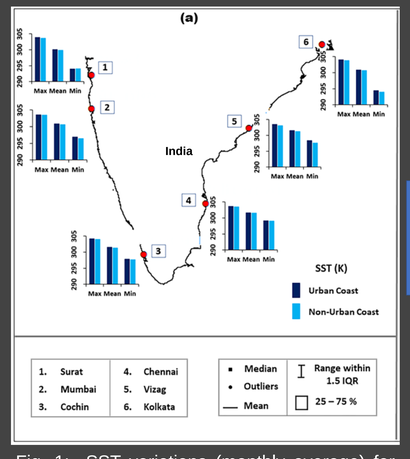

Fig. 1: SST variations (monthly average) for 1980–2019 by Bhattacharjee et al. (2023) [12]. Decrease of 0.1 to 0.3 K, comparing Urban Coast to adjacent Non-Urban Coast using ERA 5 data with 25 km spatial resolution

Spatial resolution: five times higher!

Data

- Analysis of Sea Surface Temperature (SST)
- SST datasets are of high quality and maturity [13]
- **OSTIA**
  - Global Ocean **OSTIA** Sea Surface Temperature and Sea Ice Reprocessed dataset: high spatial resolution with 0.05° (5 km at equator) and daily time series [14]
  - Multi satellite mission approach, spaceborne thermal infrared sensors and in-situ measurements from buoys and ships feed data driven model

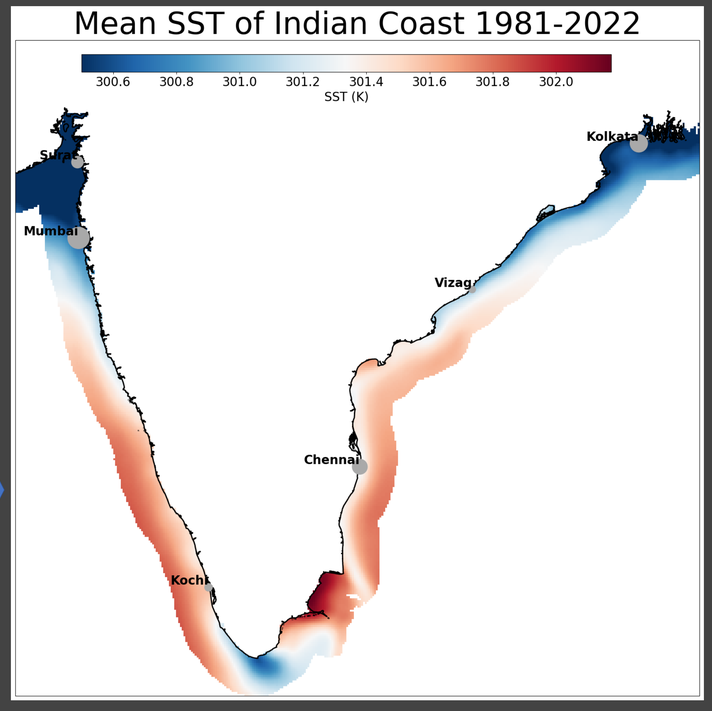

Fig. 2: Mean Sea Surface Temperature along Indian coast. Urban study sites in grey, size of circle corresponds to population. North-South temperature gradient and coastal cold water currents or upwelling visible. Over-regional processes seem to dominate spatial SST distribution

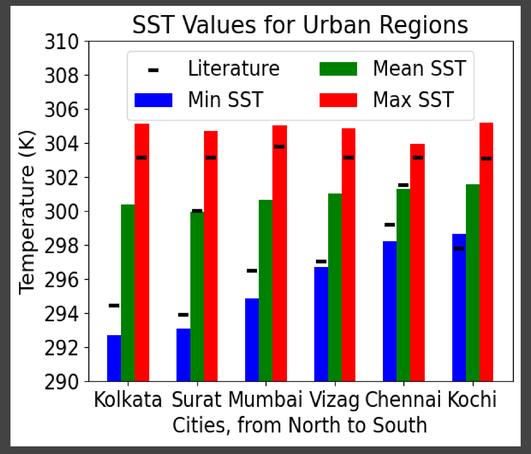

Fig. 3: Mean, Min. and Max. SST over 40 Years of six urban sites compared with literature [12] values. Regions are listed from North (left) to south (right). Min. is lower and Max. is higher compared to literature values. Mean is comparable. North south gradient visible

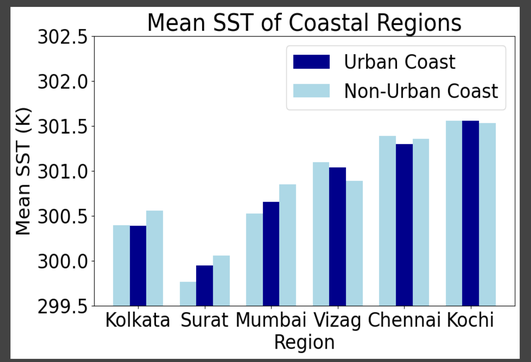

Fig. 4: Mean SST over 40 Years of six urban sites compared to adjecent Non-Urban Coast (10 – 30 km distance). No accumulated urban heat measurable. North (left) to South gradient visible for urban locations.

Conclusions

- Over-regional processes seem to dominate spatial SST distribution
  - North-South gradient and cold water currents, especially on east coast
- Results of Bhattacharjee et al. (2023) not reproducible with OSTIA data
  - Difference in Min. and Max.: Different temporal resolution (Monthly average vs daily average)
  - Mean is not appropriate statistic to identify spatially and temporally distributed anomalies

Outlook

- Reproduce analysis with Era 5 data → Critically examine methodical workflow
- Expand analysis to different climate/continents
  → Stronger urban/non-urban gradient in cold waters?
- Quantify coastal marine heat waves and correlate with city location
  → Investigation of temporal anomalies

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