# UTILISING WEATHER STATION, SATELLITE AND POPULATION DATASETS TO ESTIMATE URBAN HEAT ISLAND OVER LOCATIONS IN THE MIDDLE EAST AND NORTH AFRICA (MENA) REGION

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# Introduction

- Local weather and climate conditions are affected by the presence of cities, through their perturbation of the surface energy balance
- Urban Heat Island (UHI) → land surface and near surface air temperatures are higher over a city compared to its rural surroundings
- In order to determine and project this local warming additionally to the large-scale global warming, reliable, observation-based UHI estimates are necessary for the evaluation of high-resolution, urban resolving climate model simulations

# Aim of this work

- Combine air temperature station records with urbanization data derived from land and population data
- Examine and provide credible urban-rural temperature differences for the MENA region


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# Data & Methods - 1

- **Integrated Surface Dataset (ISD) - Global Summary of the Day (GSOD)** is a global database which consists of raw daily weather elements: Td, Tmax, Tmin, Wind Speed etc.

- There are more than 10,000 stations globally in ISD-GSOD (including the MENA region)

- Quality control and analysis was performed in the provided data:
  - Multiple years of data were analyzed to ensure continuity: 2000 – 2021 year period was selected
  - Only valid stations were selected (number of NAs < 10% in 21-year period)
  - Mean values for each station were calculated based the 5/3 rule from WMO technical report


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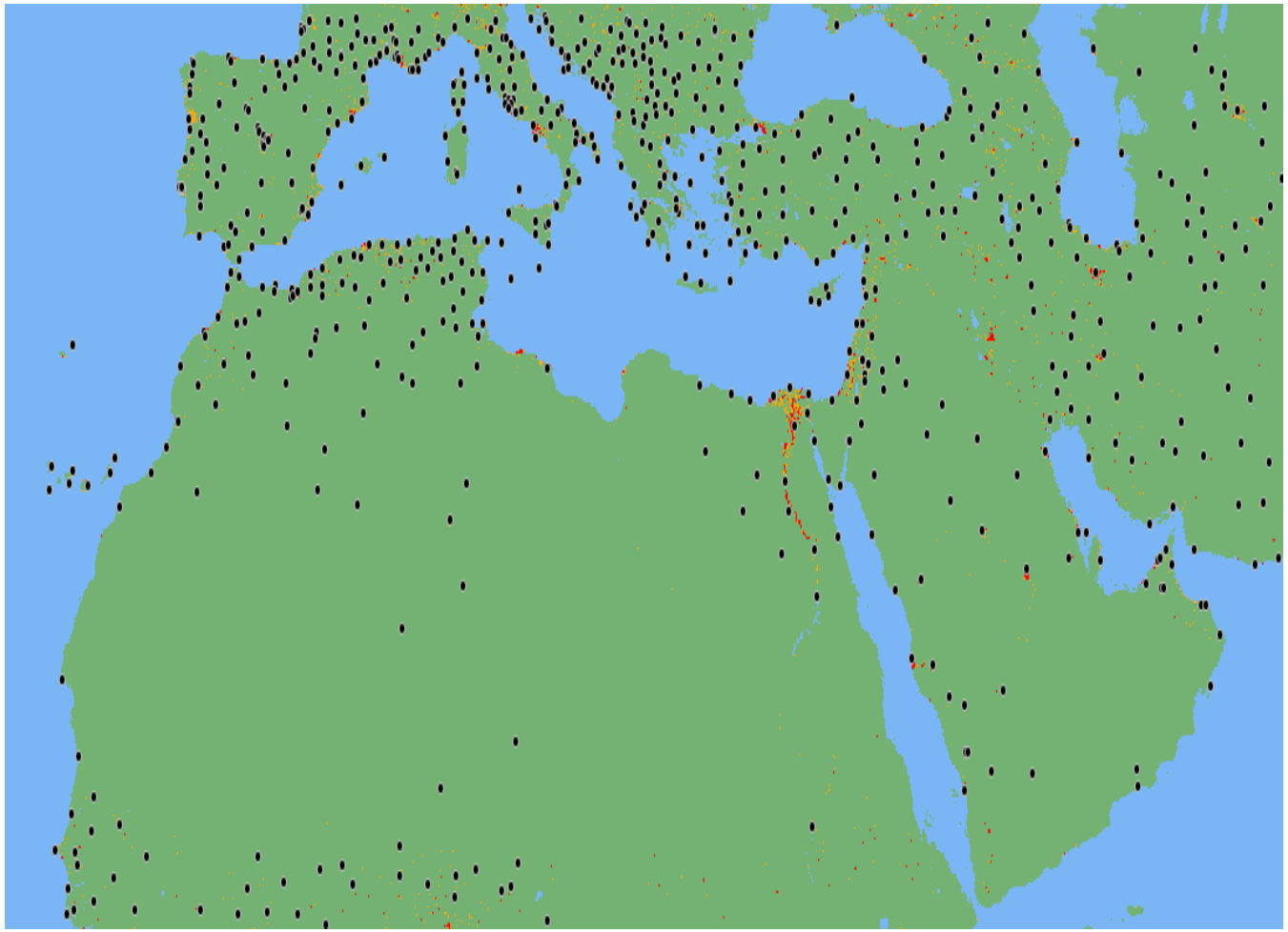
# Representation of Data -1



- **GHS Settlement Model layers (GHS-SMOD):** Derived from GHS-POP and GHSBUILT
- This method was designed to combine information from population censures with built-up data and to downscale population into a grid of 1 km resolution

- The new layer represents 3 classes characterization for each grid, based on the population of inhabitants per $km^2$ and the built-up surface share on permanent land
- There are 700 valid daily stations for the MENA region

- **Valid station:** <10% missing values in 21-year period
- **Period selected:** 2000 – 2021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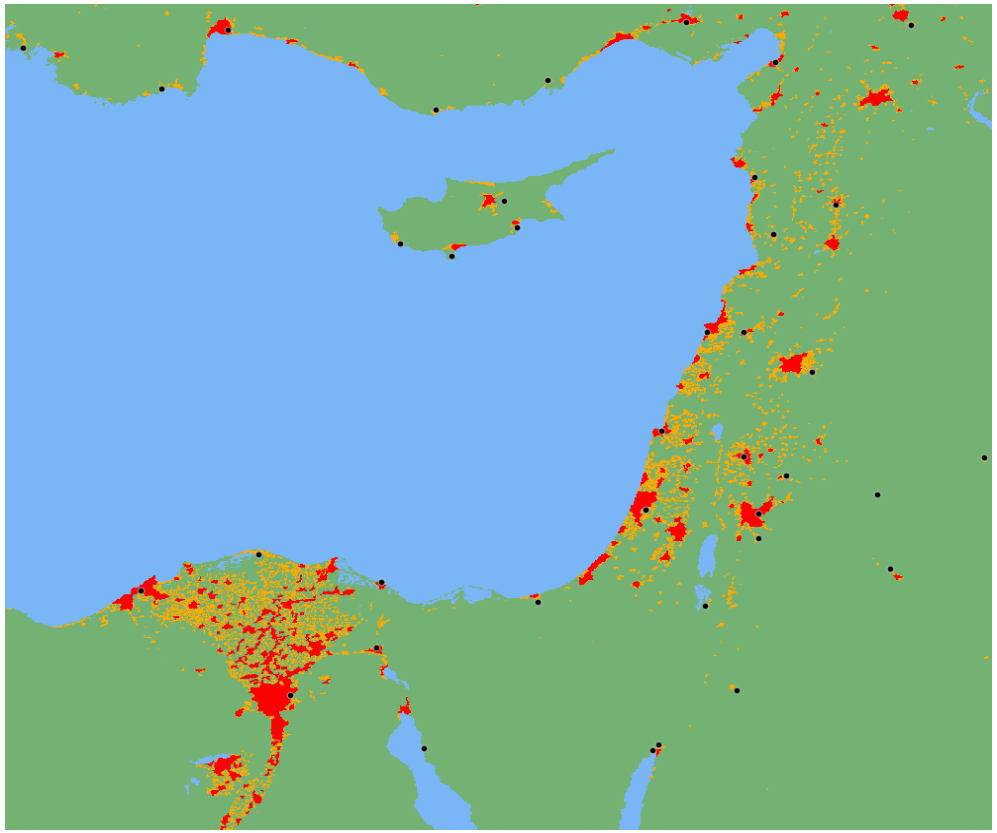
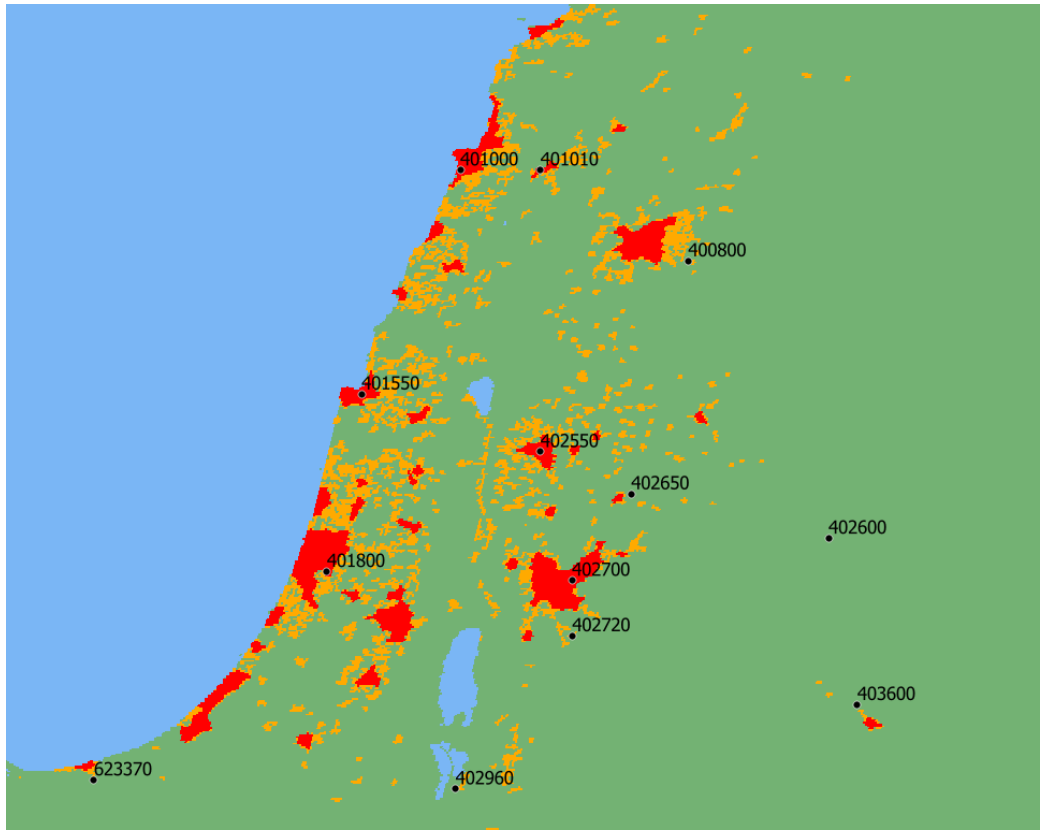
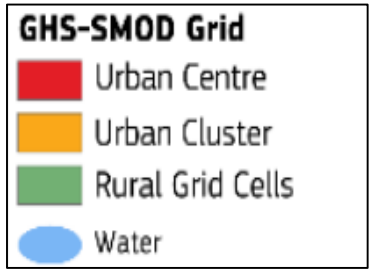
# Representation of Data - 2

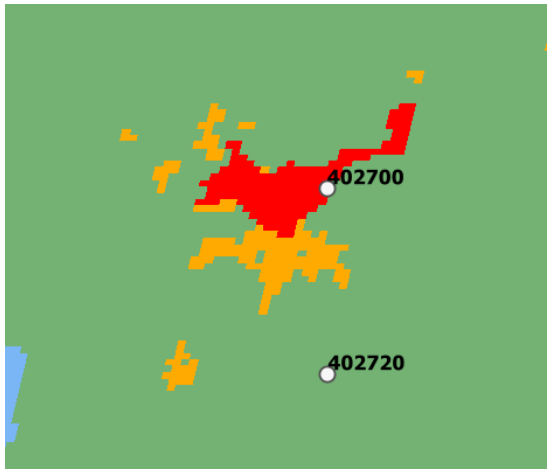




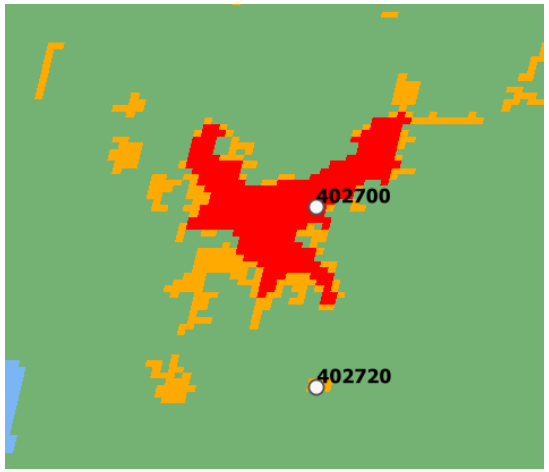
# Representation of Data - 3

- A closer view of the GHSL layers
- Through the years cities are growing →changing the class of the grid
- Layer of year 2015 was selected for the following analysis based on the validity of the observation data
- This is an example of Urban-Rural pair of Stations in Amman, Jordan

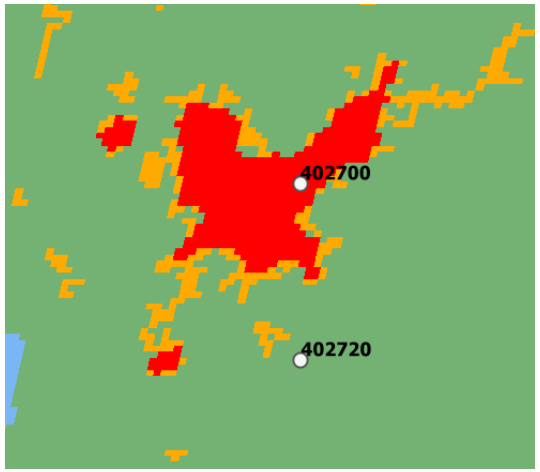


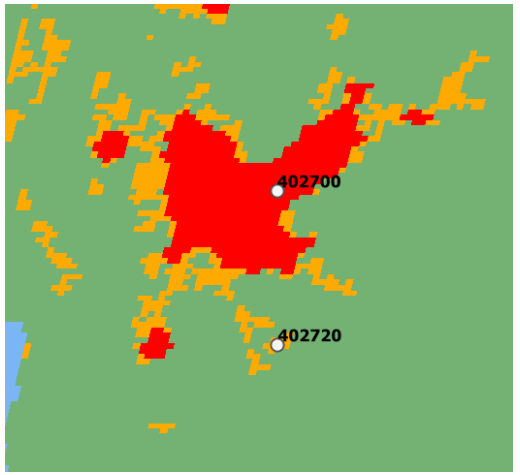

1975




1990



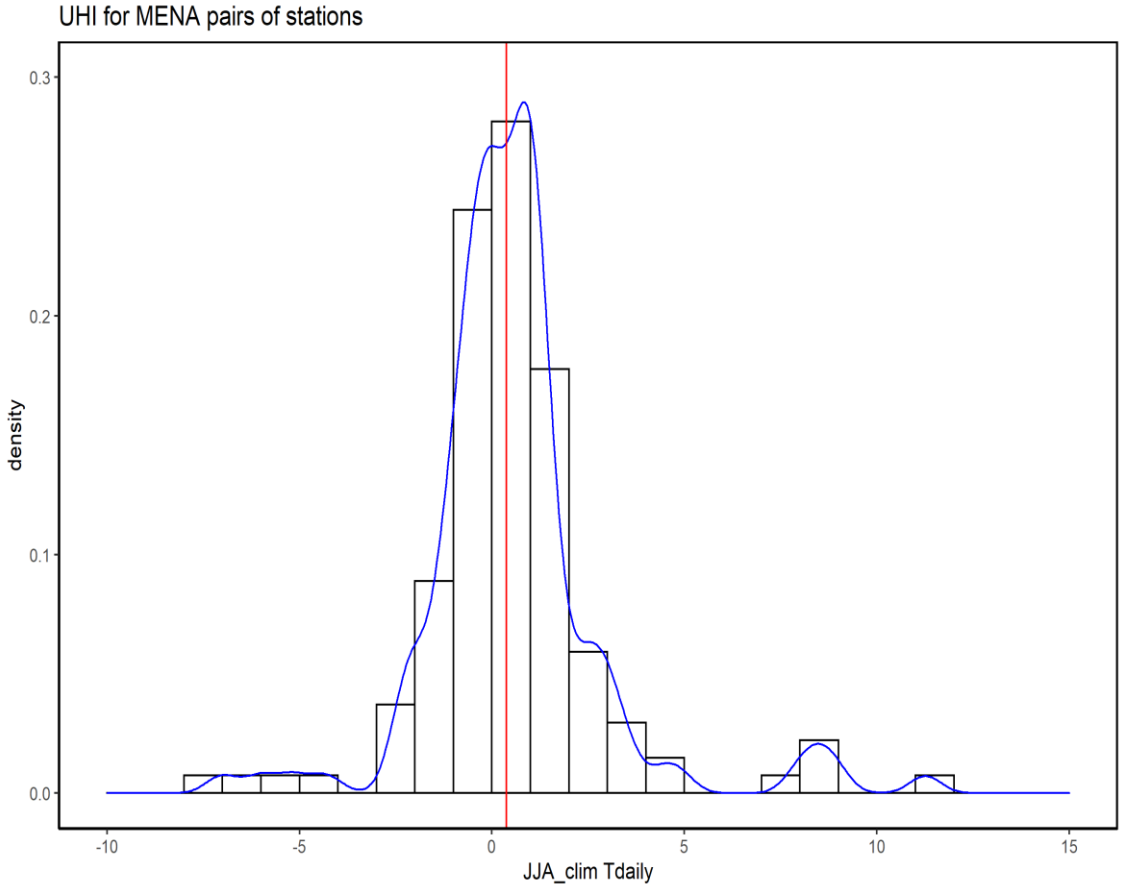

2000




2015

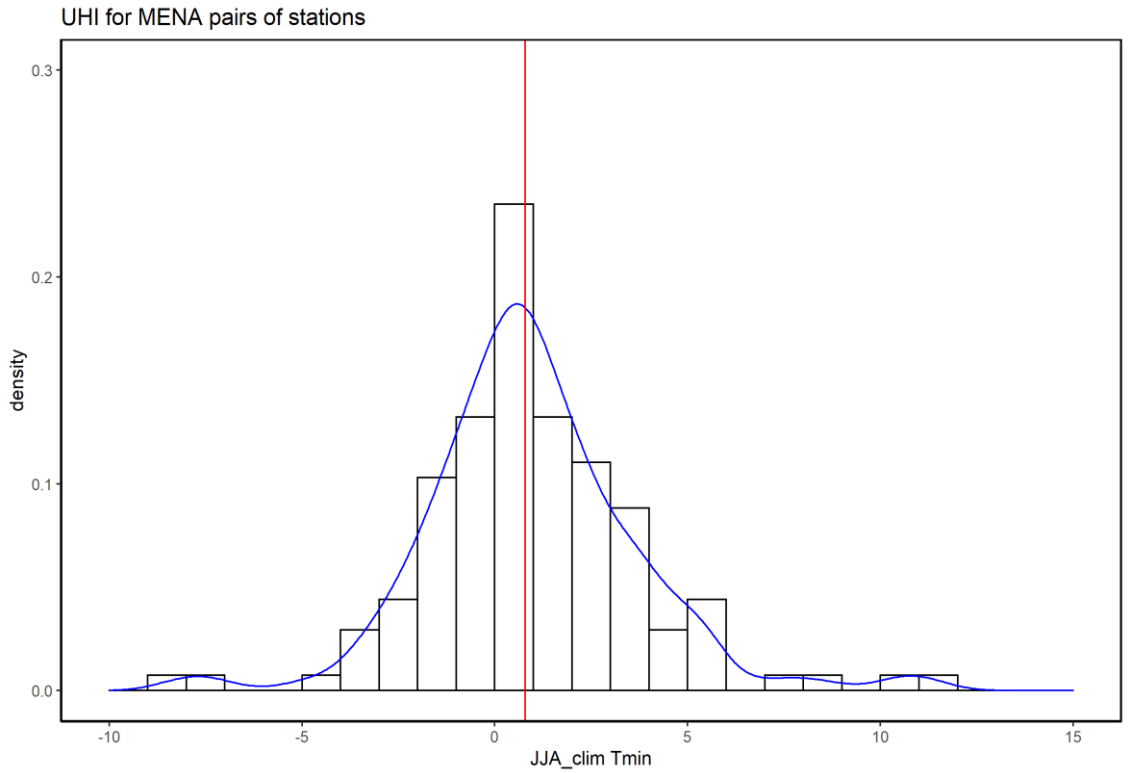
# Results - 1

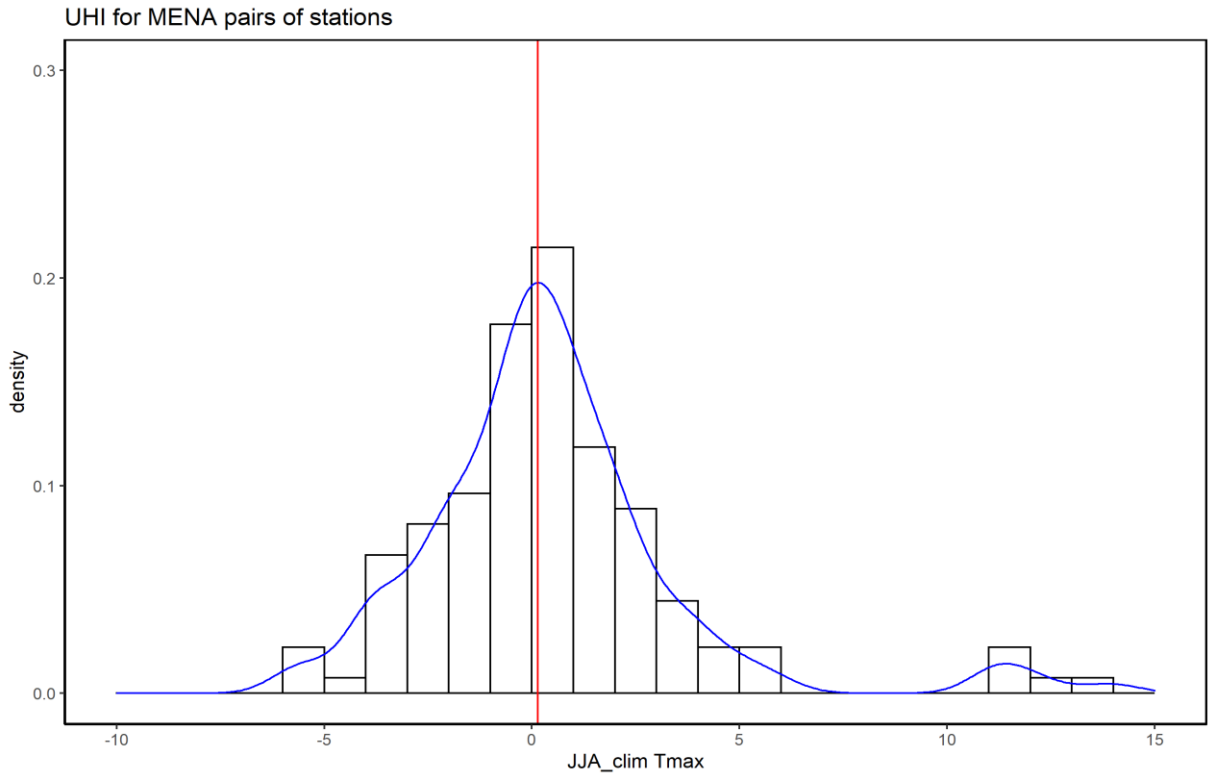
- For the MENA region 137 pairs of urban-rural meteorological stations were identified
- **Criteria used:**
  - Distance between the stations < 100 km (in country level)
  - Monthly mean followed by 5/3 rule:
    - Months with more than 5 NAs or 3 consecutive missing days → **monthly mean = NAs**
    - **JJA_clim** = average 21 years monthly data for each station
- Urban stations → "**Urban Centre**" from GHSL
- More than 80 pairs of stations have positive UHI( up to 5 degrees) in JJA climatology values



# Results - 2

- JJA_clim_Tmin → positive UHI for the night time values
- JJA_clim_Tmax → negative UHI for the day time values

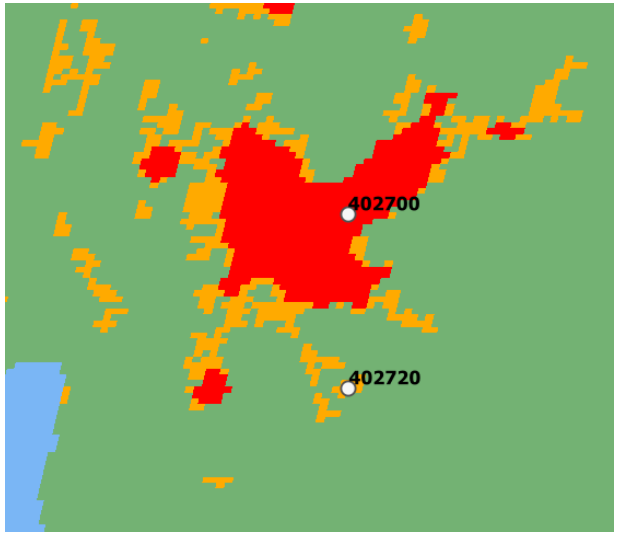


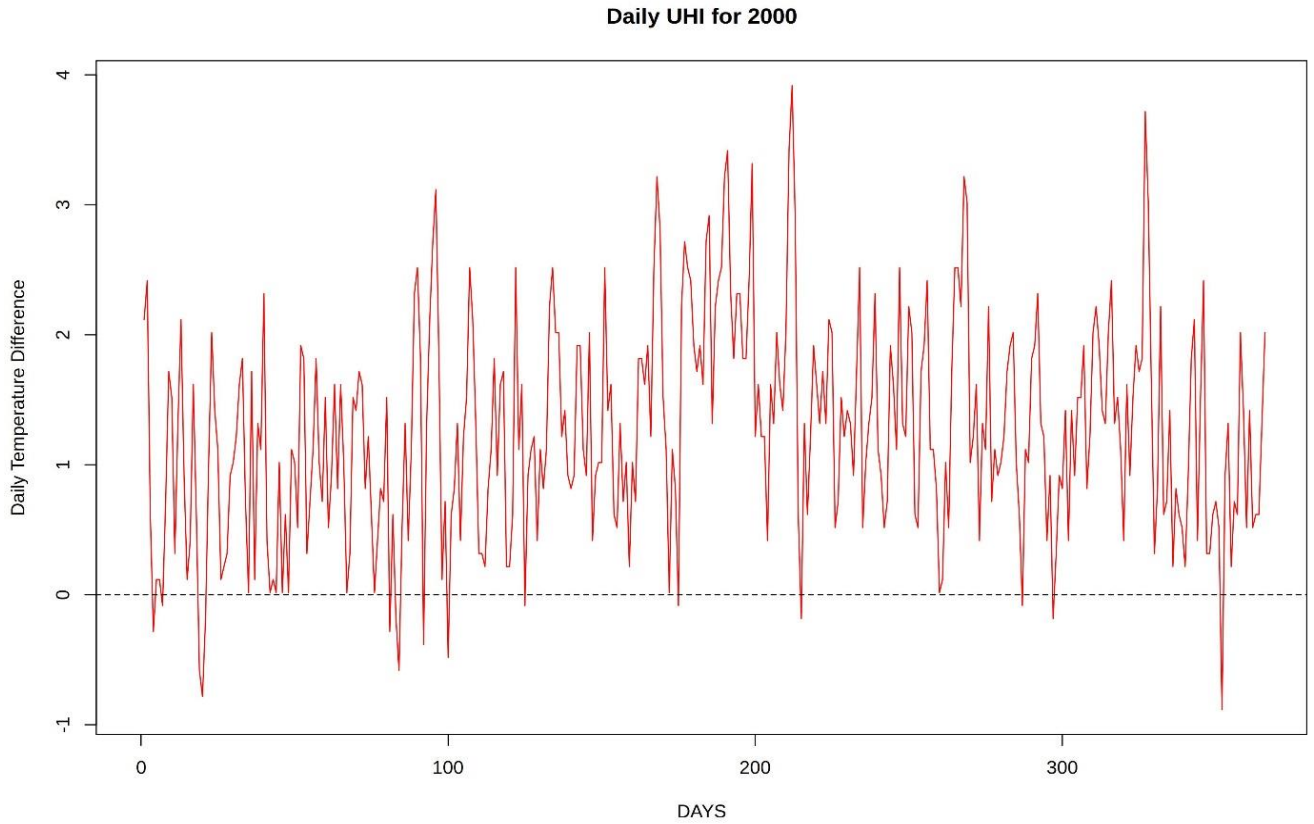



# An example of a pair Urban – Rural Station

- **Location:** Jordan
- **Distance:** 27 km
- **Urban station:** Queen Alia Int. (402700)
- **Rural station:** Marka Int. (402720)

Lapse rate correction for elevation on Daily temperatures




**UHI = Tdaily_urban – Tdaily_rural**

# Conclusions

- A combination of GHSL-SMOD data and temperature observations from ISD-GSOD stations was performed
- About 60 % of the pairs selected have positive UHI (from the summer monthly averages)
- Year 2000 → UHI_daily > 0 through out the year

**Future work:**

- In order to evaluate the model we have to consider other meteorological elements ( i.e., Wind Speed) and geomorphological details of the region
- Include hourly period calculations for diurnal cycle
- We want to finalize credible UHI pairs for RCM evaluation **(Constantinidou et al.)**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# Thank you for your attention!

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CELSIUS
Projecting temperature extremes

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