Identification of Hotspots for Heatwaves using Big Data
Sang-Wook Kim, Taehyun Kim, Jongchul Park, and Yeora Chae
Korea Environment Institute

Introduction
This study identifies hotspots for a heatwave using the high-resolution big data of Seoul, South Korea.
- Resident credit information and floating population data are used as socio-economic factors in 100 m grid resolution.
- High resolution (1 km) temperature forecast data downscaled from Dong-Naie Forecast (Digital Short-range Forecast) system is used as a meteorological factor.
- The hotspots are determined by high-temperature areas in the vulnerable regions.

Data & Method
- Period: 2017–2018 JJA (June–July–August)
- Domain: Seoul, South Korea (Figure 1)
- Data for Socio-economic Condition
  - Average annual income per person in grid point (Korean Credit Bureau)
  - Floating population: the number of people in grid point (K, annual mean population of each year removed)
- Data for Meteorological Condition
  - Point observed temperature: Seoul station (Korean Meteorological Administration, climatology removed)
  - Temperature distribution: Forecast field downscaled (1 km) from KMA short-range forecast (Lee, et al., 2019)

Hotspot identification algorithm
- Socio-economic condition (Static Vulnerable Regions + Dynamic Vulnerable Regions)
- Meteorological condition (Heatwave Forecast)

Table 1. Data description

<table>
<thead>
<tr>
<th>Name</th>
<th>Resolution</th>
<th>Production</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident Credit Information</td>
<td>100 m (grid)</td>
<td>ECB</td>
<td>Resident population average annual income</td>
</tr>
<tr>
<td>Floating Population</td>
<td>100 m (grid)</td>
<td>KT</td>
<td>Floating population information data based on 174 usage</td>
</tr>
<tr>
<td>Station Temperature</td>
<td>1 km (grid)</td>
<td>KMA</td>
<td>Station observed temperature (17400)</td>
</tr>
<tr>
<td>Temperature Forecast Field</td>
<td>1 km (grid)</td>
<td>KMA &amp; HIFS</td>
<td>High resolution temperature forecast field downscaled from Dong-Naie Forecast (Digital Short-range Forecast)</td>
</tr>
</tbody>
</table>

Data & Method (continued)
- Floating population: the number of people in grid point (K, annual mean population of each year removed)
- Floating population data pre-processing
- Population density by grid over time (spatial movement path does not appear)
- Process for removing temperature-independent population variability
- The floating population time series from the original population change (Residual population R08, Figure 4 & 5)
  - model 1: population moves from residential area to work place
  - model 2: population moves from work place to residential area or nightlife area

Results
- Static Vulnerable Region
  - Low-income residential regions (lower 20%)
  - The region showing lower average income of the population living in each grid
  - The more vulnerable to heatwaves expected
- Fixed in time within a year and a season (static in time)
- Mainly distributed in the southwest and the northeast area of Seoul (red and blue boxes in Figure 3a)

- Dynamic Vulnerable Region
  - Small population variability & weak correlation with temperature
  - The region where population mobility is less responsive to temperature
  - Various times of day and space
  - Fixed in time and space (dynamic)
- Floating population data processing
- Population density by grid over time (spatial movement path does not appear)
- Process for removing temperature-independent population variability
- The floating population time series from the original population change (Residual population R08, Figure 4 & 5)
  - model 1: population moves from residential area to work place
  - model 2: population moves from work place to residential area or nightlife area

- Dynamic Vulnerable Region (continue)
  - The region where the residual population is the most vulnerable and weakly correlate to the point observed temperature at each time
  - Dynamic Vulnerability
  - Vulnerability = 1

Hotspots for heatwaves
- The vulnerable regions where heatwaves are expected
- The region where 33°C (heatwave threshold of KMA) or higher temperature is forecasted while satisfying both static and dynamic vulnerability
- Dynamic change in and time and temperature, e.g. 2018-08-01 (forecasted at 2018-07-31 05KST, Figure 7)
- Hotspot clusters: often appearing in densely populated residential areas with alleys and low building height

Discussion
- The hotspot identification system figures out where damage expected in objective ways
- The number of floating population data is expected to support heatwave management such as making decisions about the place and timing to provide disaster relief resources.