

Guideline for Calculating Intersection Density

This script calculates the intersection density for dissemination areas (DAs) across Canadian provinces. Intersection density measures the number of 3+ way road intersections within a 1-kilometer buffer around the centroid of each DA. Here's a clear explanation of the main steps and datasets used in the process:

1. Setting Up the Environment

To handle large datasets and perform spatial calculations efficiently in R, parallel processing is enabled using `future.apply`. Five CPU cores of an i7-8700 CPU (6 cores, 12 threads) are allocated for the processing, leaving one core free for system tasks to ensure smooth operation. All spatial operations are done in EPSG:3347 (NAD83 / Statistics Canada Lambert), which is ideal for accurate distance and area calculations in Canada. Memory limits were also adjusted to handle the demands of large spatial datasets (`future.globals.maxSize = 1 * 1024^3`).

2. Preparing Dissemination Areas

The script uses dissemination area shapefiles corresponding to the analysis year:

- **2006:** `gda_000b06a_e.shp`
- **2011:** `lda_000b11a_e.shp`
- **2016:** `lda_000b16a_e.shp`
- **2021:** `lda_000b21a_e.shp`

From these files, centroids for each DA are specified, and 1-kilometer buffers are created around the centroids. These buffers represent the areas where intersection density will be calculated.

3. Loading Road Network Data

Road network shapefiles for each year are used:

- **2006:** `grgf000r06a_e.shp`
- **2011:** `lrnf000r11a_e.shp`
- **2016:** `lrnf000r16a_e.shp`
- **2021:** `lrnf000r21a_e.shp`

To focus on walkable environments, limited-access roads (e.g., highways) are removed:

- For 2006, limited-access roads were identified by their names (e.g., "HWY", "AUT", "EXPY", etc.) and filtered out.
- For 2011, 2016, and 2021, limited-access roads were filtered using classification codes (10, 11, 12, 13).

4. Dividing the Province into Tiles

The script divides each province into 10 km x 10 km tiles. This step ensures spatial operations are performed on smaller datasets, reducing memory use and speeding up the calculations. Each tile is processed independently, focusing only on the roads and buffers within that tile.

5. Calculating Intersections

For each tile, the script:

- Intersects the road network with the tile boundary to isolate local road segments.
- Identifies 3+ way intersections by counting how many road segments meet at each point. Only intersections with three or more connecting roads are considered valid.

6. Calculating Intersection Density

For each DA buffer:

- The script counts the number of valid intersections within the buffer.
- Intersection density is calculated as the number of intersections divided by the buffer area (approximated as a circle with a 1-kilometer radius).

7. Saving Results

Once all tiles for a province are processed:

- Results are aggregated at the DA level, recording the total intersection count and intersection density for each buffer.
- These results are exported as Excel files, with each province's results saved separately.

The output files include:

- **DAUID:** Unique identifier for each dissemination area.
- **Intersection Count:** Total number of intersections within the buffer.
- **Intersection Density:** Number of intersections per square kilometer within the buffer.