Bangkok Liveability

Release 1.2

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CHAPTER

ONE

ABOUT

1.1 About

Meeting the challenges of the 21st century—climate change, population growth and migration, the rise of non-communicable disease, increasing inequalities—will require coordinated, global efforts across multiple sectors and levels of government. The 17 Sustainable Development Goals (SDGs) provide a global framework for promoting human development and wellbeing, reducing inequalities, and tackling these challenges in an environmentally sustainable manner. Cities will play a central role in meeting these aspirations; indeed, SDG 11 specifically calls for sustainable, socially inclusive, and resilient cities that promote wellbeing. In doing so, the SDGs recognise the importance of cities given the trends toward population growth and urbanisation: already, half the world's population lives in cities, and by 2050 this will rise to more than two-thirds.

Urbanisation acceleration is fastest in cities within low-to-middle income countries, and globally, Asia is urbanising most rapidly. Well-designed, liveable cities are essential for providing infrastructure that supports economic activity, governance, commerce and trade, while providing access to health and social services, education, and civic opportunities.

Liveable cities are also sustainable cities: they prioritise sustainable modes of transportation (e.g. walking and cycling) over carbon-intensive dependence on automobiles.

However, rapidly urbanising cities face a number of challenges. Urban sprawl, environmental degradation, waste production and management, and noise, air and water pollution are major concerns for these cities and their residents. Consequently, there is urgency to increase understanding, capacity, and strategies that enhance liveability in low-to-middle income cities which go beyond Australian-centric definitions.

These issues are also central to the SDGs and promoting wellbeing. For example, access to sanitation and clean drinking water (SDG 6) is critical to promoting residents' wellbeing and impacts on the liveability of an urban area; yet, Australian liveability definitions do not include access to sanitation or drinking water.

This Partnership Project will extend a knowledge sharing and capacity building partnership between RMIT University, United Nations Global Compact-Cities Programme, Bangkok Metropolitan Administration, and the Victorian Government Department of Health and Human Services, by building on the 'Contextualising Liveability in Bangkok' Pilot Project findings. We will further refine our knowledge of context-specific liveability in a rapidly urbanising low-to-middle income city context (Bangkok, Thailand). This will involve development and application of a suite of open source liveability indicators aligned to the Sustainable Development Goals with the aim of developing long-term local capacity. It is anticipated that this proof of concept will likely be scalable and relevant to other cities globally.

The aims of this project are to:

1. Identify and source open source liveability spatial data inputs and indicators aligned with the Sustainable Development Goals and suitable for use in the Bangkok context;
2. Apply and test conceptually relevant liveability indicators across Bangkok;
3. Develop the capacity of the Bangkok Metropolitan Administration for utilising liveability data in policy and planning; and
4. Generate translational outputs that maximise the useability and scalability of indicators for application for different cities.

Link to pilot project final report (PDF)

1.1.1 Funding

This project was funded by the VicHealth Sustainable Development Goals Partnership Round. Hannah Badland is funded by an RMIT University Vice Chancellor's Senior Research Fellowship.

1.1.2 Project partners

- Healthy Liveable Cities Group, RMIT University
- VicHealth
- Bangkok Metropolitan Administration
- UN Global Compact – Cities Programme
- Victorian Government Department of Health and Human Services

CHAPTER

TWO

INDICATORS

2.1 Study region boundaries

2.1.1 data

Bangkok subdistrict boundary data (BMA, 2019) were topologically corrected using GRASS and QGIS, to ensure polygon boundaries did not have gaps or overlaps. Boundaries were matched with alternate spellings in both Thai and English for corresponding regions found in data from other organisations and datasets (e.g. NSO, HDX) in order to facilitate data linkage. The final boundary layer was returned to BMA and agreed upon for usage.

Data source: `BangkokGIS (BMA)`

URL: `http://www.bangkokgis.com/bangkokgis_2008/userfiles/files/download/shapefile/administration/BMASubDistrict_Polygon.rar`

Publication year: `2018`

Target year: `2018`

Acquisition date (yyyymmdd): `20190725`

Licence: `none specified`

Spatial reference (EPSG code): `32647.0`

Date type: `vector`

Scale / Resolution: `subdistrict`

Notes: `English names not provided; these have been derived using manual linkage with data from HDX subdistricts and population data provided by BMA, with verification from Kornsupha Nitvimol of BMA.`

Data location relative to project folder: `./data/Bangkok_subdistricts_BMA_HLC_derived_20190805_cleaned_gpkg:subdistricts`

District and changwat boundaries were constructed through geometrical union of the constituent subdistricts they were aligned with. Boundaries at all three scales (subdistrict, district, changwat) were imported into the project database and used as analysis areas when constructing other indicators, as required. The area in square kilometres of each analysis area's polygonal extent was recorded. The changwat (province) of Bangkok was used to define the Bangkok metropolitan study region extent. A ten kilometre buffer extending beyond this is used when conducting analyses of access to resources, so that access to destinations outside the study region would be accounted for peri-urban regions when undertaking network analysis.

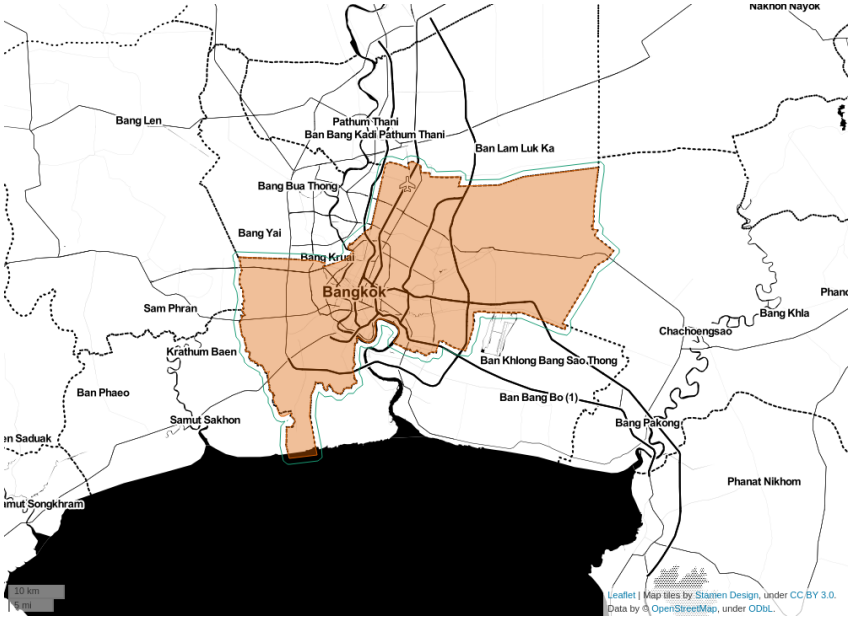


Fig. 1: Bangkok study region

2.2 Population and communities

2.2.1 data

Population statistics targetting Bangkok in 2018 were received from the Bangkok Metropolitan Administration, indexed by subdistrict. Fields included total population, sex strata, household, number of communities, and population in communities.

Data source: `BMA`

URL: `http://www.bangkok.go.th`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190805`

Licence: `none specified`

Scale / Resolution: `subdistrict`

Notes: `Derived population layer based on data received from Korn Nitviminol (BMA) via e-mail on 5 August 2019`

Data location relative to project folder: `./data/Bangkok_subdistrict_population_BMA_HLC_derived_20190805.csv`

Population data were linked with boundaries using corresponding subdistrict ID numbers. Density measures were calculated using population statistics relative to analysis area size.

Population per km²

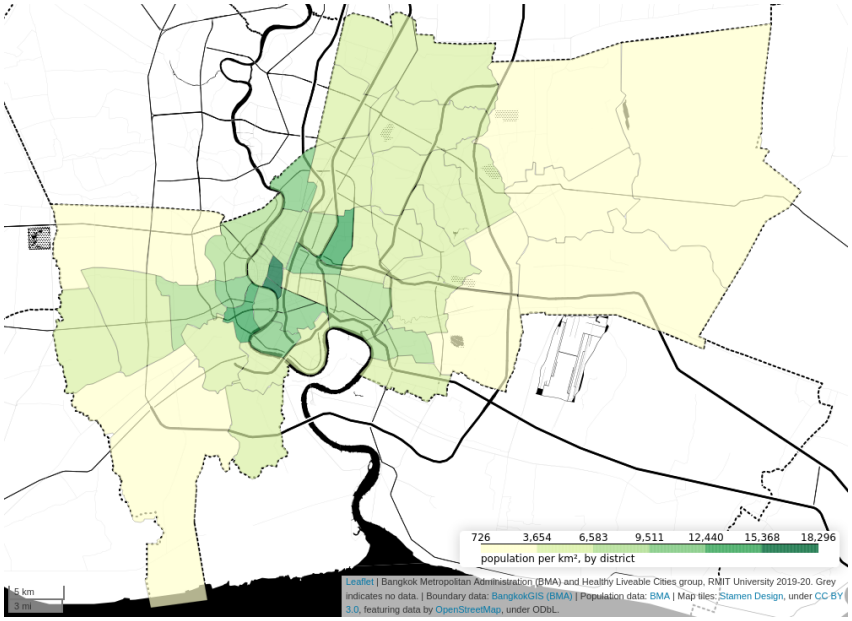


Fig. 2: Population per km², by district

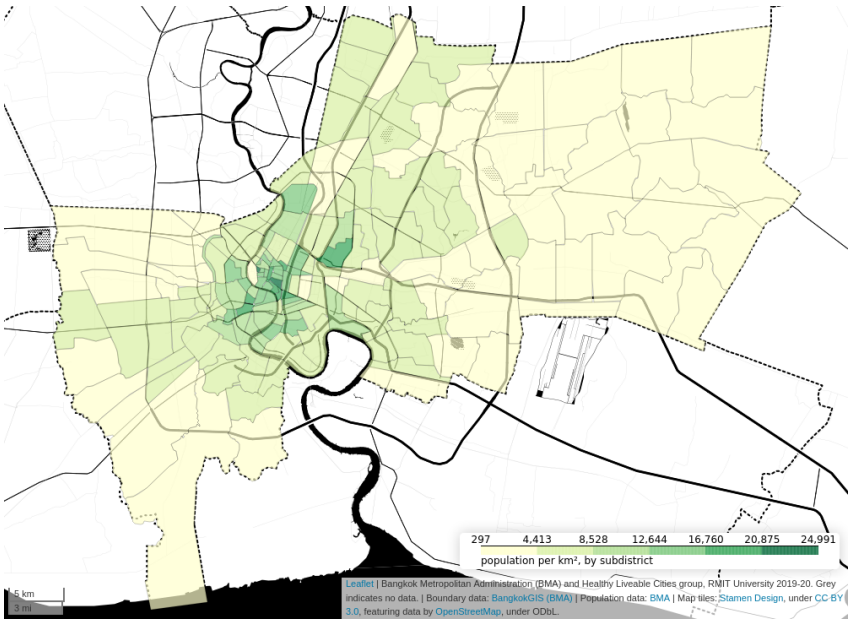


Fig. 3: Population per km², by subdistrict

Households per km²

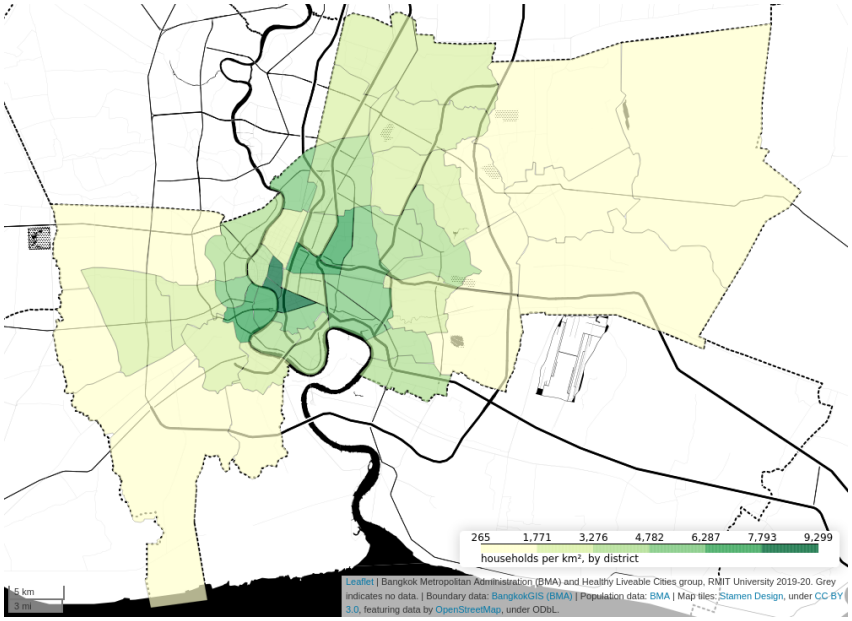


Fig. 4: Households per km^2, by district

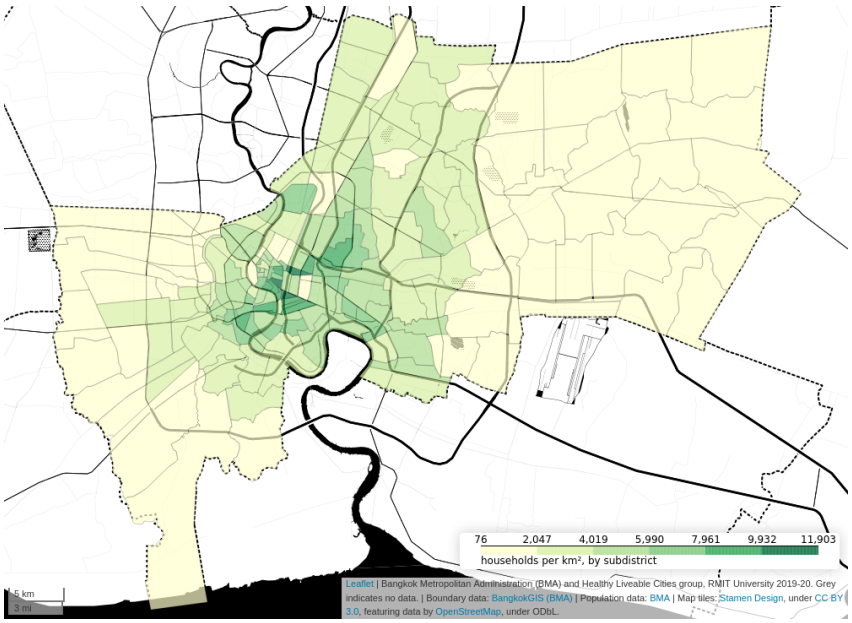


Fig. 5: Households per km^2, by subdistrict

Communities per km²

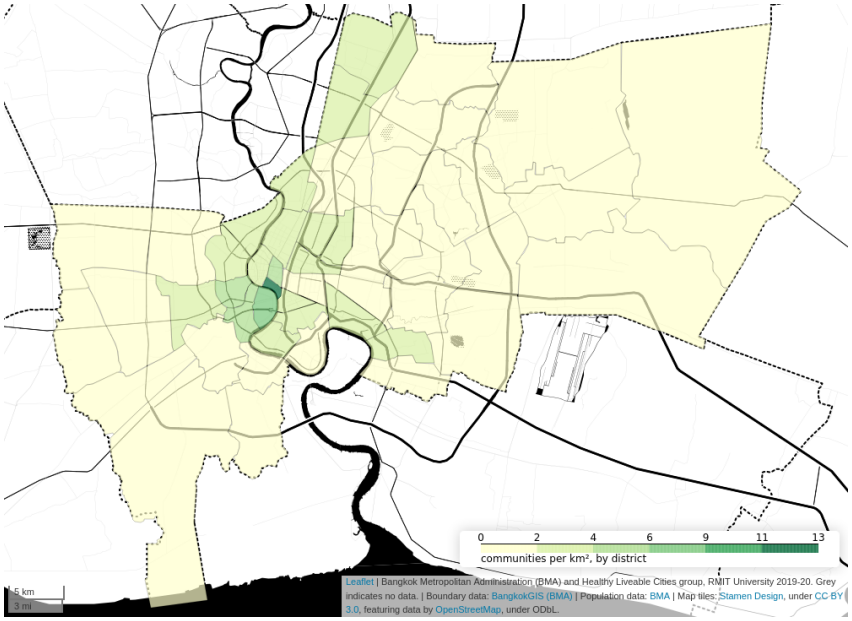


Fig. 6: Communities per km^2, by district

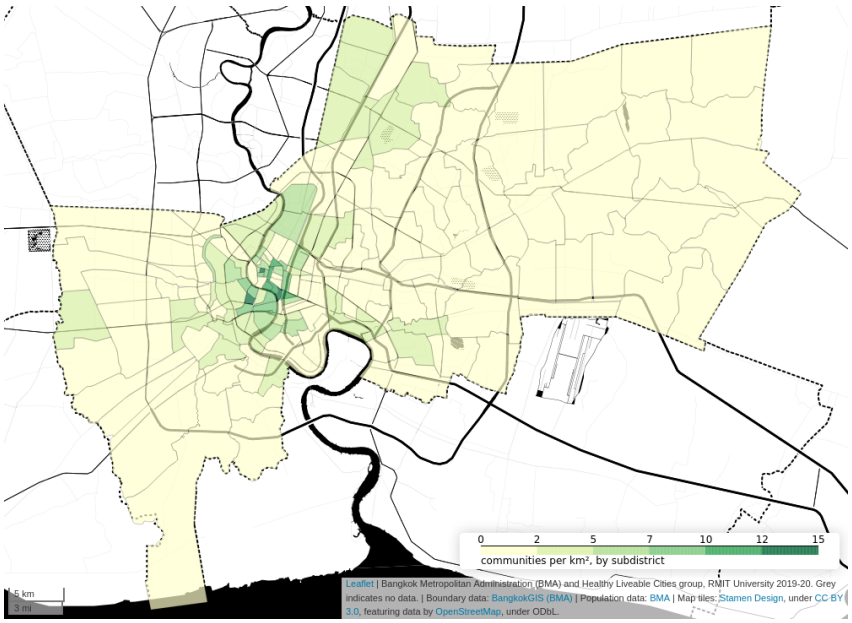


Fig. 7: Communities per km^2, by subdistrict

Population in communities per km²

Aligns with Sustainable Development Goals: 11.

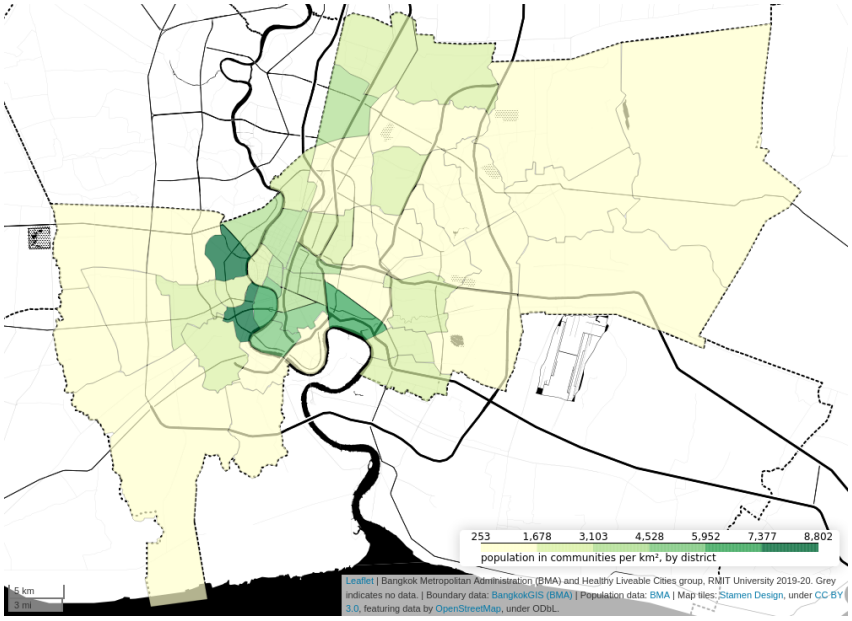


Fig. 8: Population in communities per km^2, by district

Aligns with Sustainable Development Goals: 11.

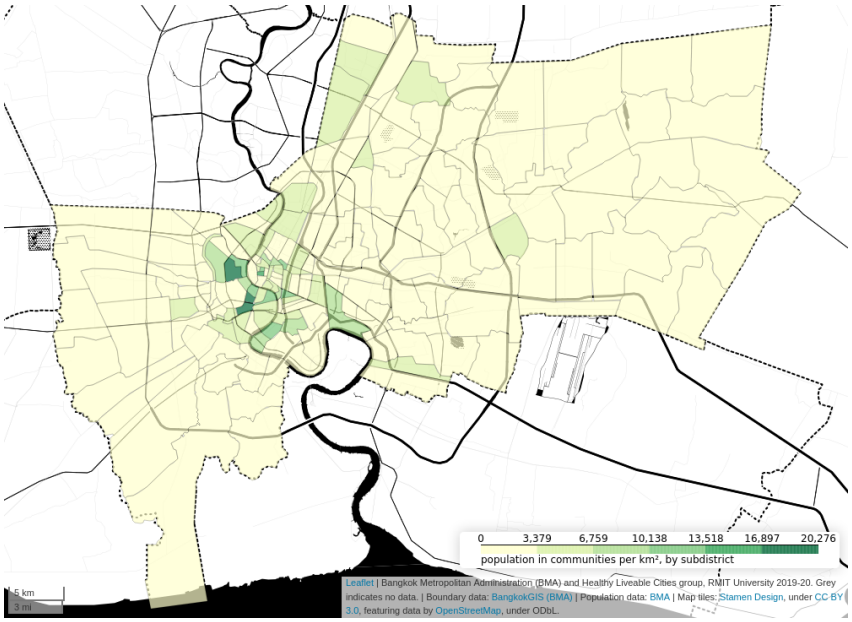


Fig. 9: Population in communities per km^2, by subdistrict

2.3 City problems impacting health and wellbeing

2.3.1 Water quality/pollution

คุณภาพน้ำ/มลพิษทางน้ำ

Water quality refers to the physical, chemical, biological and sensory properties (for example, taste) of water. Water pollution means the presence of toxic chemicals in groundwater and biological substances in excess of what is found in natural water and which may pose a threat to human health and / or the environment.

Dataset: Canal water quality

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. The data comprised sample point records of canal water quality for 130 canals where Dissolved Oxygen (DO) less than 2 amount 130 canals (224 storage points). Data were cleaned for processing and aligned with area IDs.

Data source: `Department of Drainage and Sewerage, BMA`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190617`

Licence: `none specified`

Date type: `float`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190617/canal water quality 2018_final.xlsx`

Canal water storage DO (mg/L; 2018)

The average milligrams of dissolved oxygen per litre (DO mg/L) recorded at sample points within each analysis area was recorded.

Aligns with Sustainable Development Goals: 3, 6, 9, 11, 12, 14.

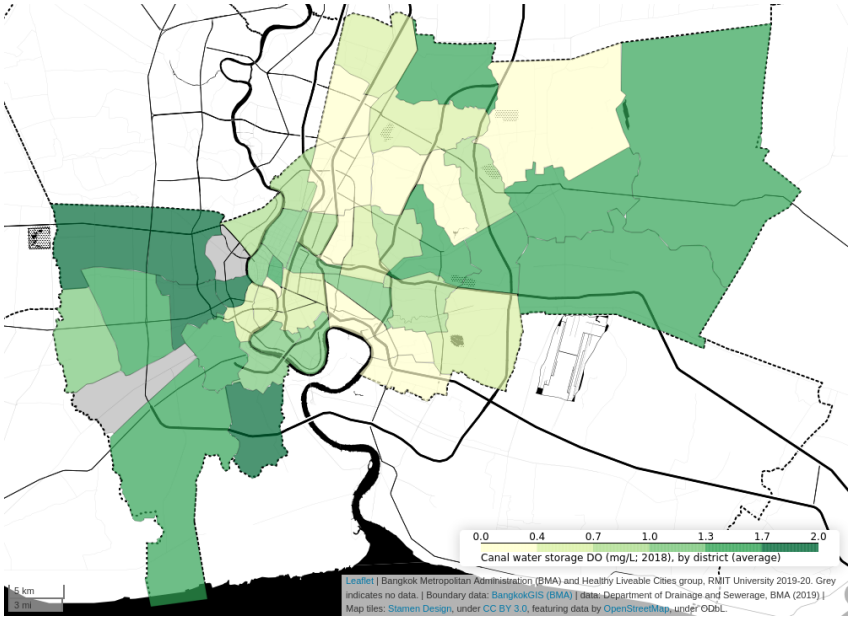


Fig. 10: Canal water storage DO (mg/L; 2018), by district

Canal water storage BOD (mg/L; 2018)

The average milligrams of biochemical oxygen demand per litre (BOD mg/L) recorded at sample points within each analysis area was recorded.

Aligns with Sustainable Development Goals: 3, 6, 9, 11, 12, 14.

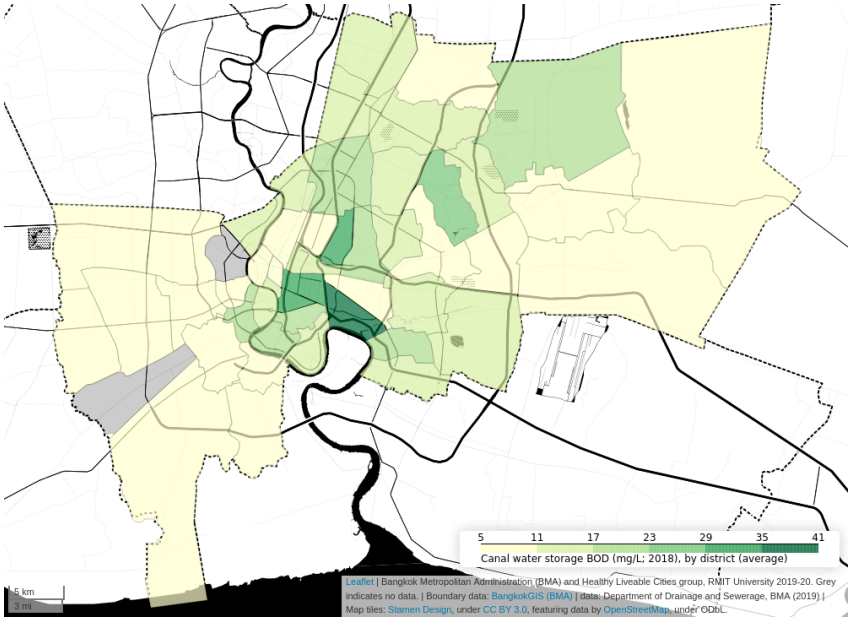


Fig. 11: Canal water storage BOD (mg/L; 2018), by district

Canal water storage sample locations, 2018

The count of sample points with poor water quality (< 2 DO mg/L) was recorded for each analysis area.

Aligns with Sustainable Development Goals: 3, 6, 9, 11, 12, 14.

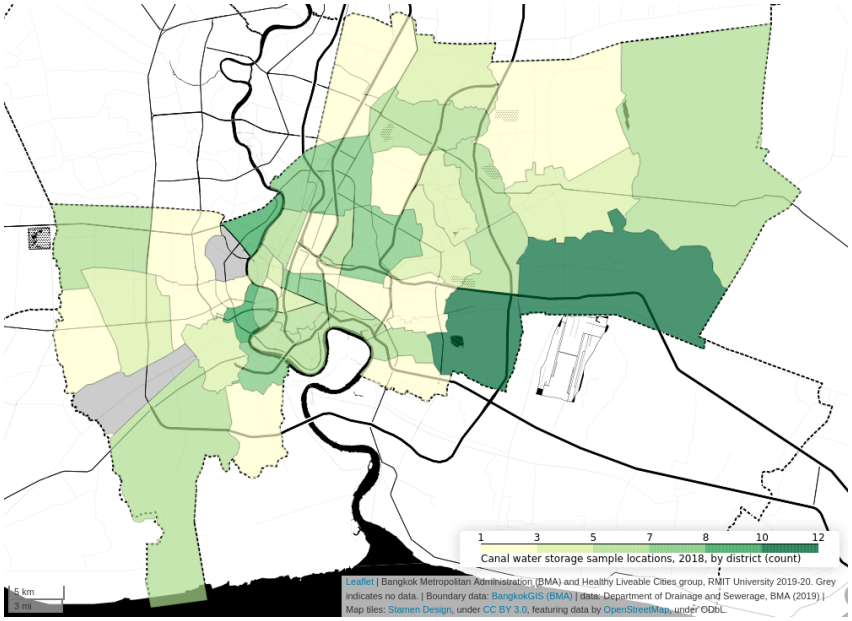


Fig. 12: Canal water storage sample locations, 2018, by district

Canal water storage sample locations, 2018 per km²

The count of sample points with poor water quality (< 2 DO mg/L) was recorded for each analysis area. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 3, 6, 9, 11, 12, 14.

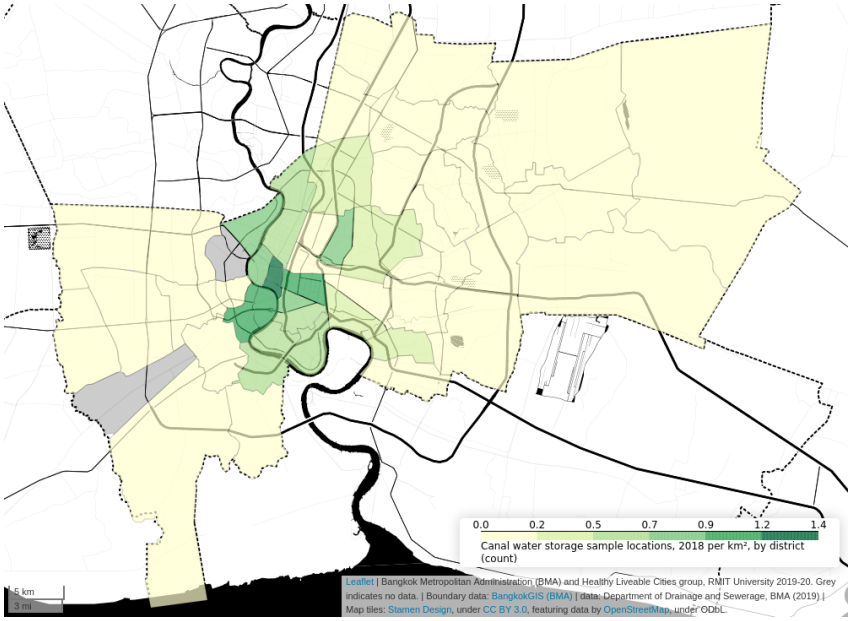


Fig. 13: Canal water storage sample locations, 2018 per km^2, by district

Canal water storage sample locations, 2018 per 10,000 population

The count of sample points with poor water quality (< 2 DO mg/L) was recorded for each analysis area. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 3, 6, 9, 11, 12, 14.

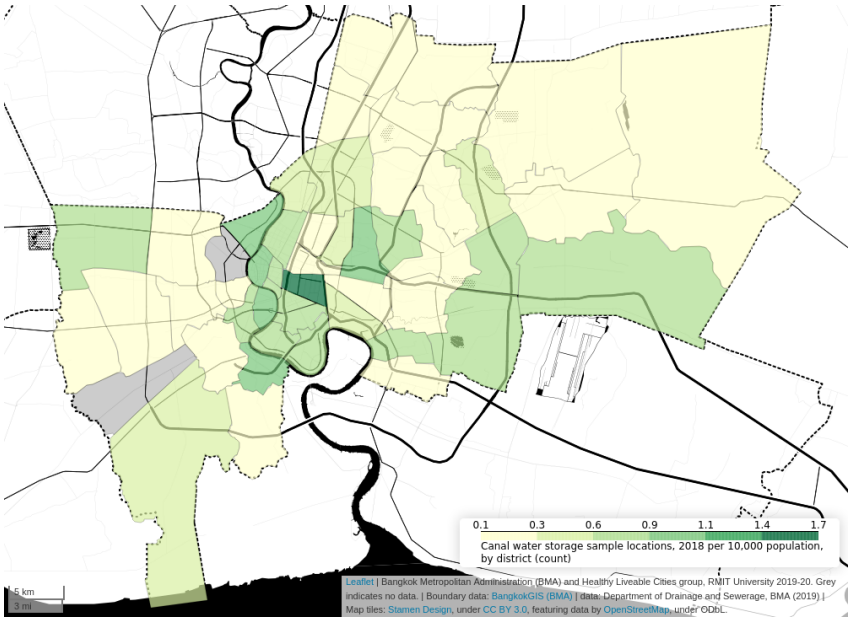


Fig. 14: Canal water storage sample locations, 2018 per 10,000 population, by district

Canal water storage sample locations, 2018 per 10,000 household

The count of sample points with poor water quality (< 2 DO mg/L) was recorded for each analysis area. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 3, 6, 9, 11, 12, 14.

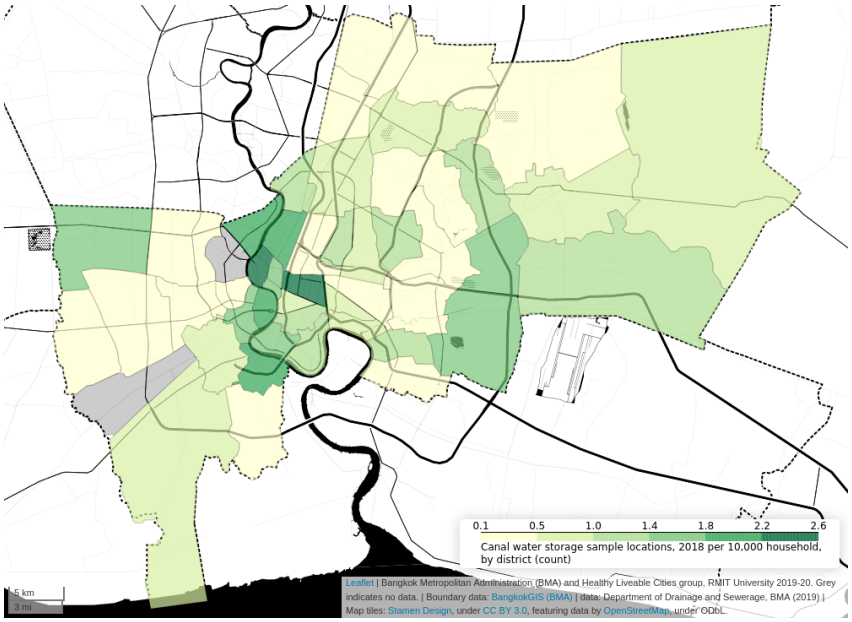


Fig. 15: Canal water storage sample locations, 2018 per 10,000 household, by district

Canal water storage BOD < 6 mg/L (2018)

The percentage of sample locations with biochemical oxygen demand less than 6 mg/L recorded within each analysis area was recorded.

Aligns with Sustainable Development Goals: 3, 6, 9, 11, 12, 14.

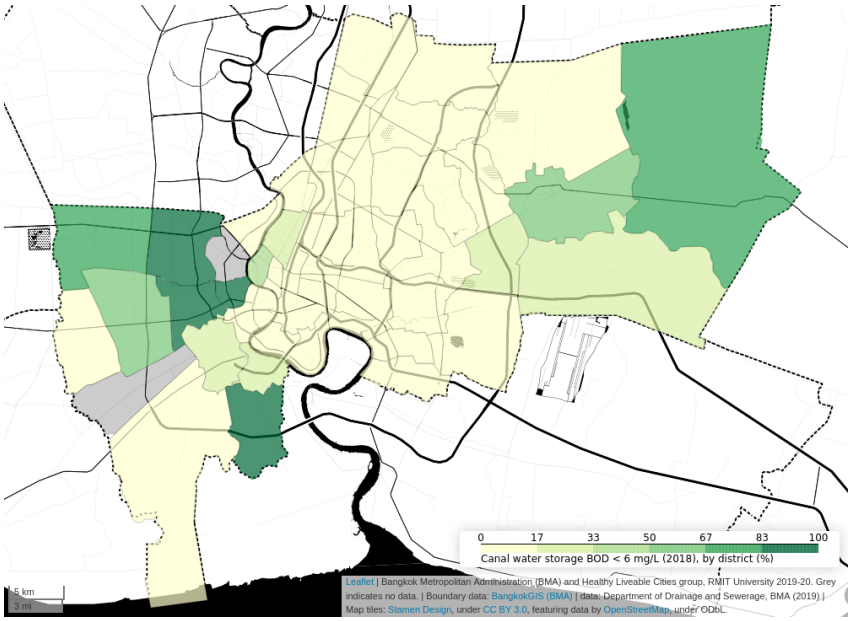


Fig. 16: Canal water storage BOD < 6 mg/L (2018), by district

2.3.2 Reduced/no car congestion

รถติดลดลง/ไม่มีรถติด

Traffic congestion is a condition that slows down transportation speed, resulting in longer travel times and increased occurances of stationary vehicles on long roads

Dataset: Traffic jam

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `BMA, sourced from https://www.grandprix.co.th/10 , opened 25 September 2019`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190930`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190930/transfer_1730651_files_296a713c/9 main Roads of Traffic Jam in Bangkok year 2018 by district and road _kn20190925.xlsx`

Number of main road of traffic jams (2018)

The count of main road traffic jams associated with each analysis area was recorded.

Aligns with Sustainable Development Goals: 11, 13.

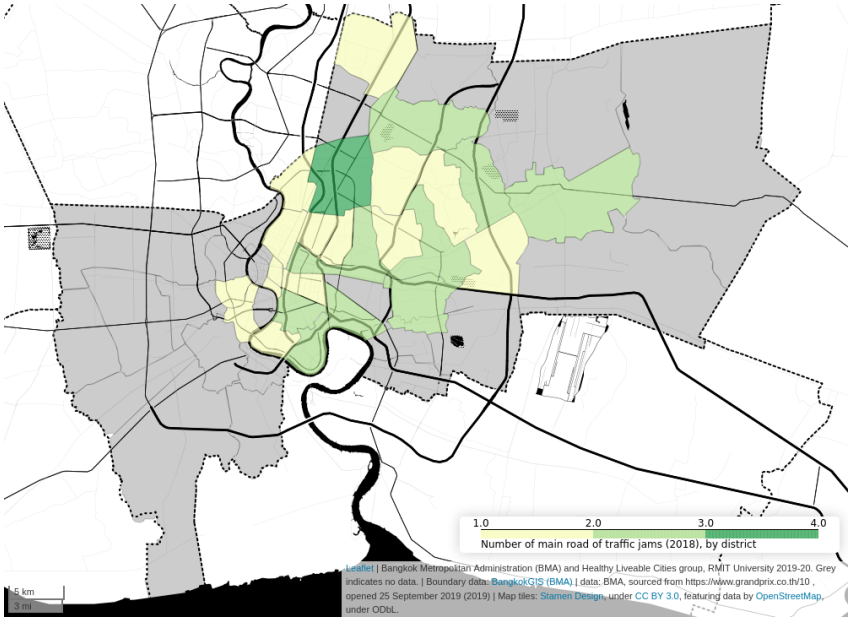


Fig. 17: Number of main road of traffic jams (2018), by district

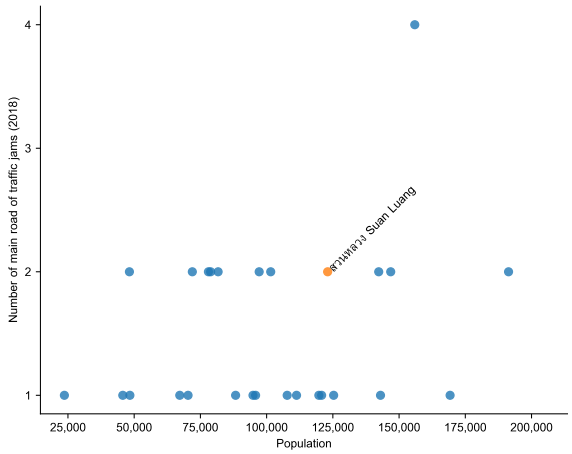


Fig. 18: Scatterplot of Number of main road of traffic jam by district by population for districts.

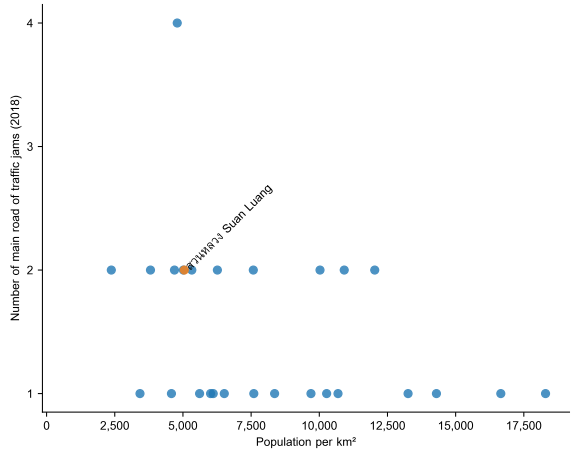


Fig. 19: Scatterplot of Number of main road of traffic jam by district by population density for districts.

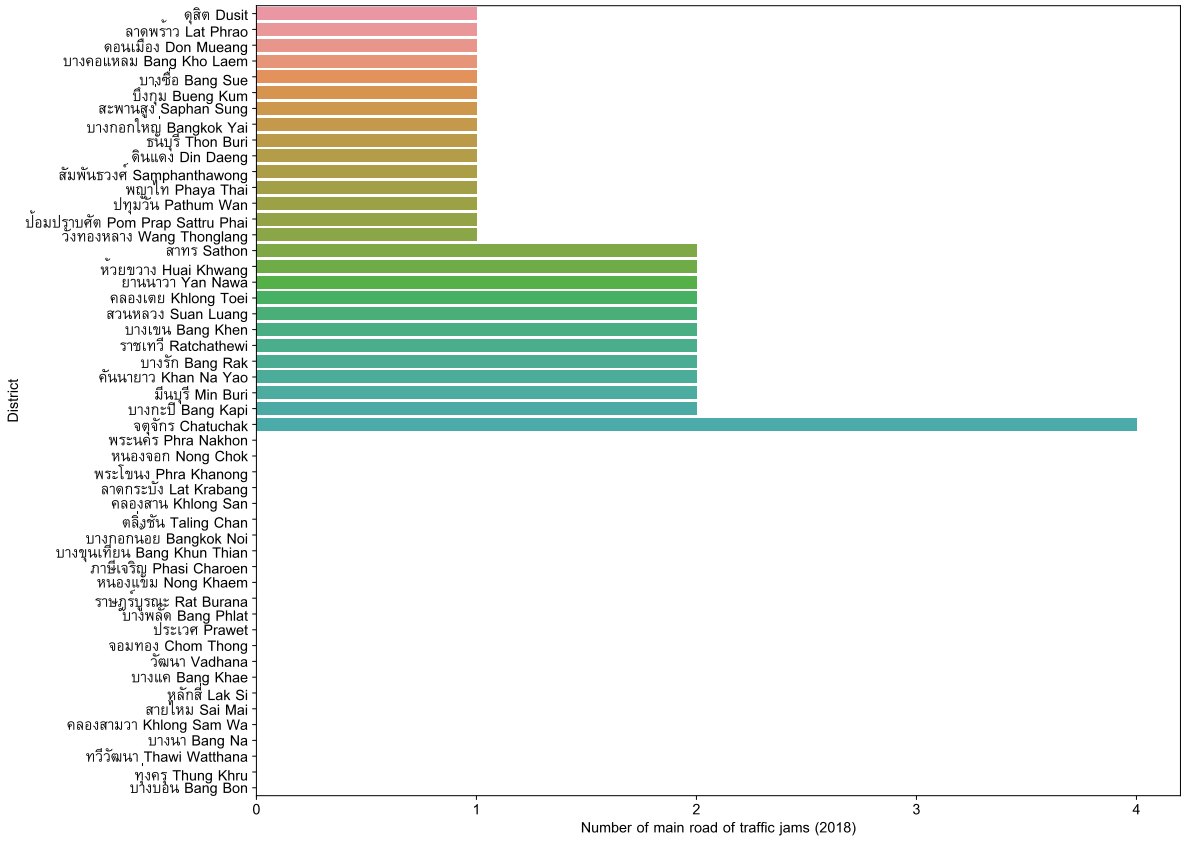


Fig. 20: Districts ranked in ascending order by number of main road of traffic jam by district with regard to number of main road of traffic jams (2018).

2.3.3 Zero waste

ไม่มีขยะ/ขยะเป็นศูนย์

Garbage (waste) means unwanted or unusable materials or any substances that are discarded after first use or unable to be reused and may be considered to be a co-product that has little economic value. Waste is divided into 5 categories which are liquid waste, solid waste, organic waste, recyclable waste and hazardous waste.

Dataset: Solid waste

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `Department of Environment, BMA`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190911`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190911/transfer_1710171_files_127133c5/solid waste in Bangkok -kn08242019.xlsx`

Annual solid waste (tonnes, 2018)

The amount of solid waste (tonnes) taken to waste transfer stations during 2018 was recorded for each district.

Aligns with Sustainable Development Goals: 11, 13.

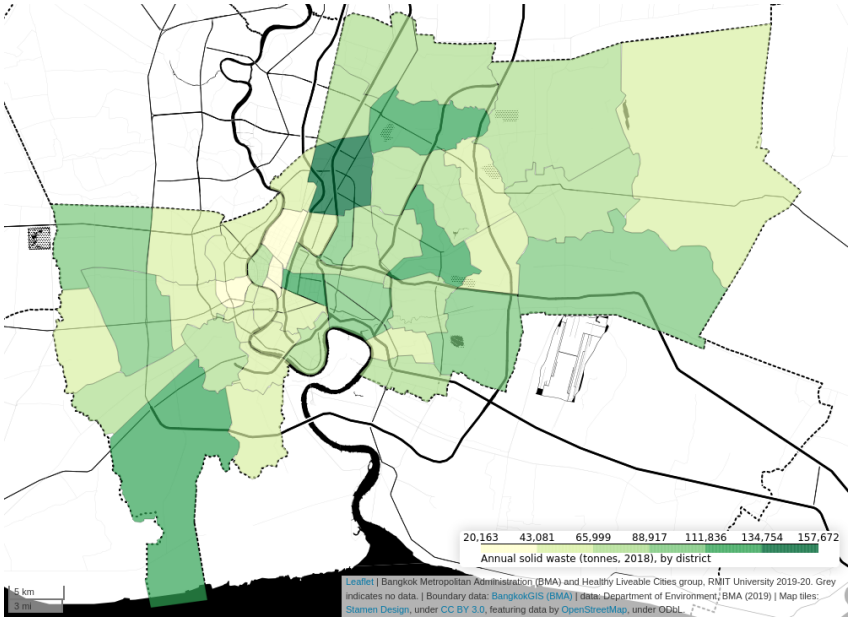


Fig. 21: Annual solid waste (tonnes, 2018), by district

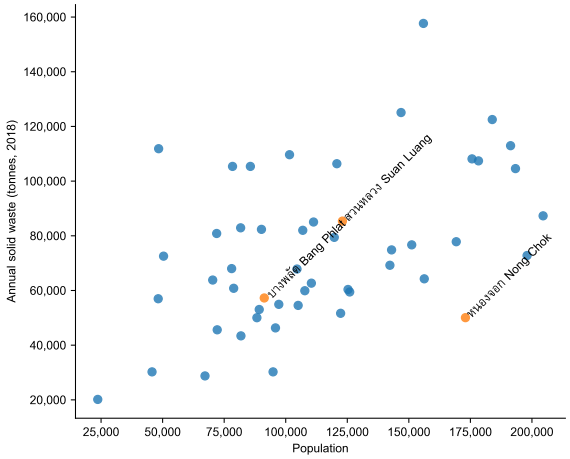


Fig. 22: Scatterplot of annual solid waste (tonnes) by population for districts.

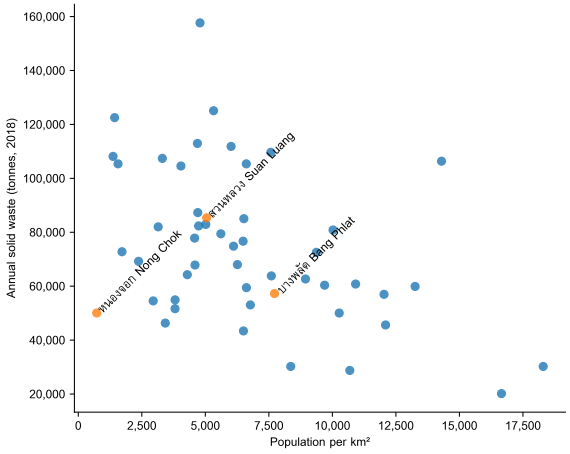


Fig. 23: Scatterplot of annual solid waste (tonnes) by population density for districts.

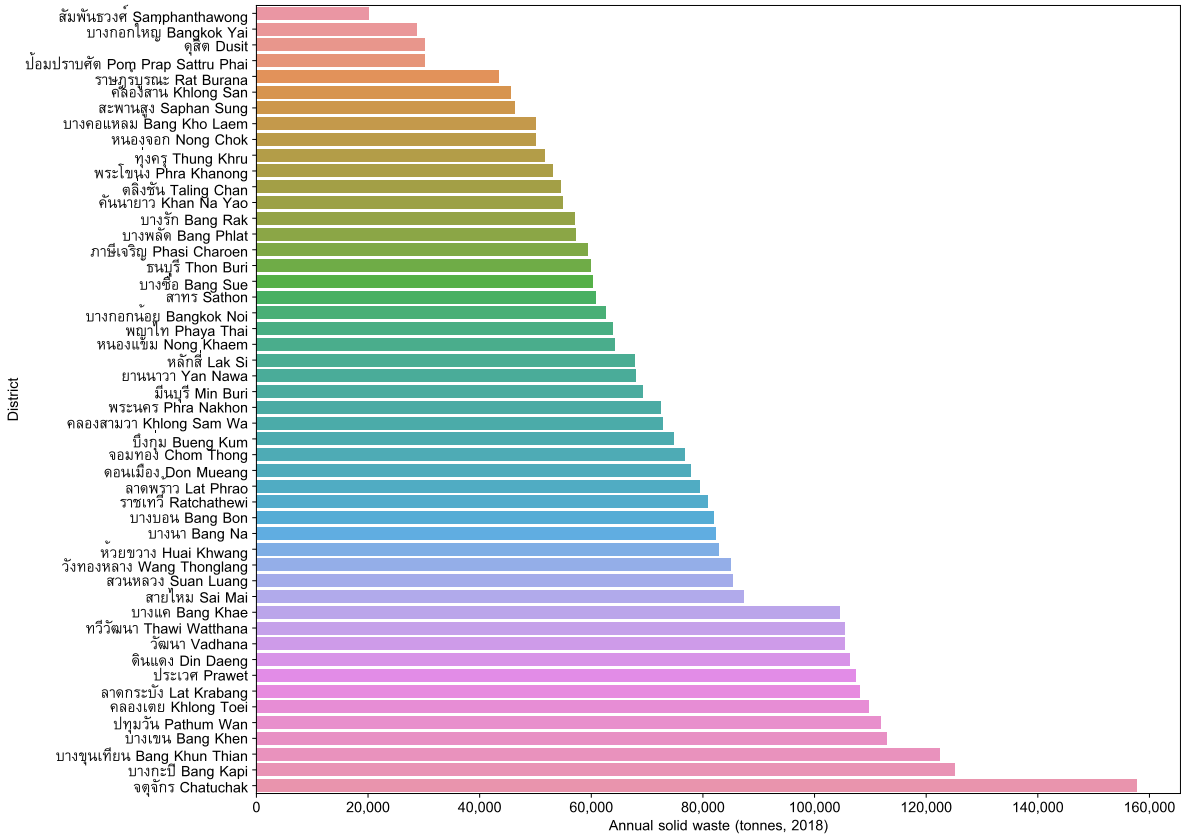


Fig. 24: Districts ranked in ascending order by annual solid waste (tonnes) with regard to annual solid waste (tonnes, 2018).

Annual recyclable waste (tonnes, 2018)

The amount of recyclable waste (waste that is managed by recycling; tonnes) taken to waste transfer stations during 2018 was recorded for each district.

Aligns with Sustainable Development Goals: 11, 13.

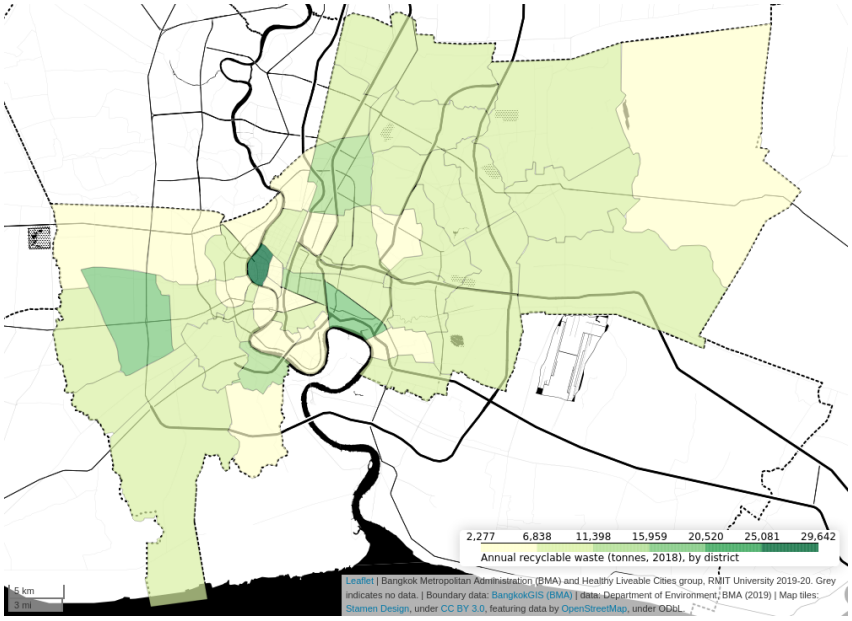


Fig. 25: Annual recyclable waste (tonnes, 2018), by district

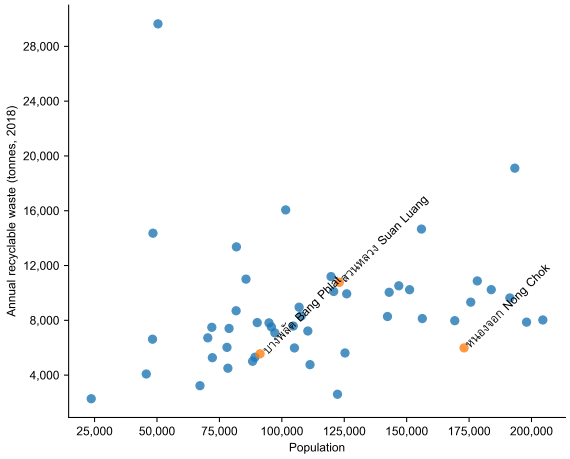


Fig. 26: Scatterplot of annual recyclable waste (tonnes) by population for districts.

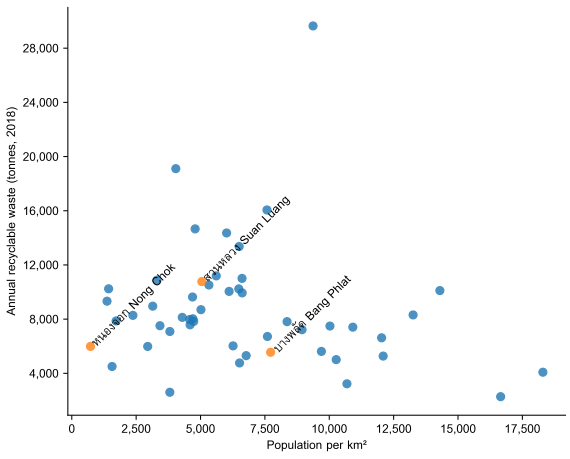


Fig. 27: Scatterplot of annual recyclable waste (tonnes) by population density for districts.

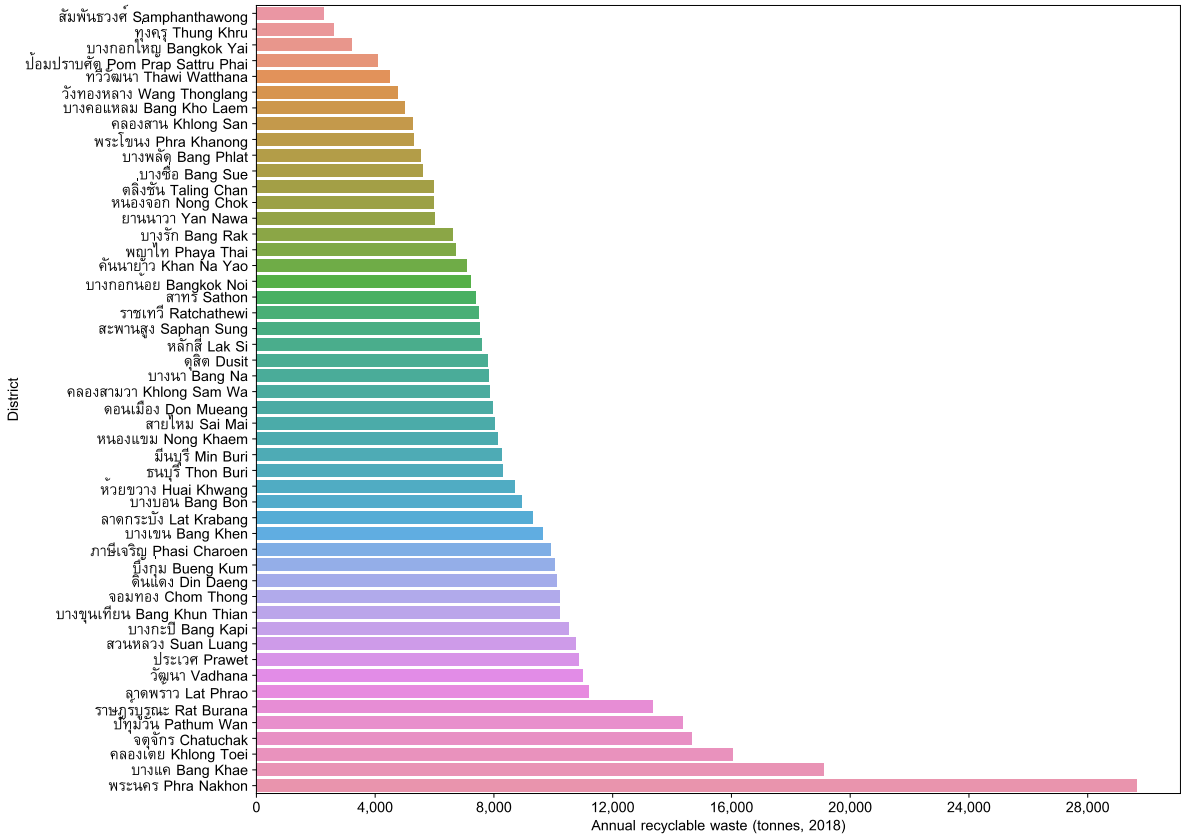


Fig. 28: Districts ranked in ascending order by annual recyclable waste (tonnes) with regard to annual recyclable waste (tonnes, 2018).

Percentage recyclable waste (tonnes, 2018)

The percentage of total waste (solid and recyclable) taken to waste transfer stations during 2018 that was recyclable was recorded for each district.

Aligns with Sustainable Development Goals: 11, 13.

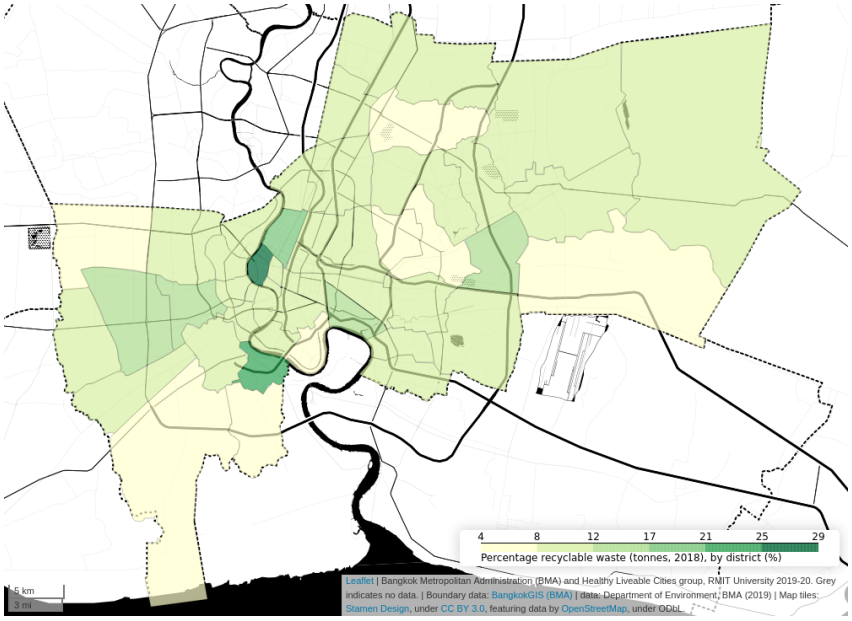


Fig. 29: Percentage recyclable waste (tonnes, 2018), by district

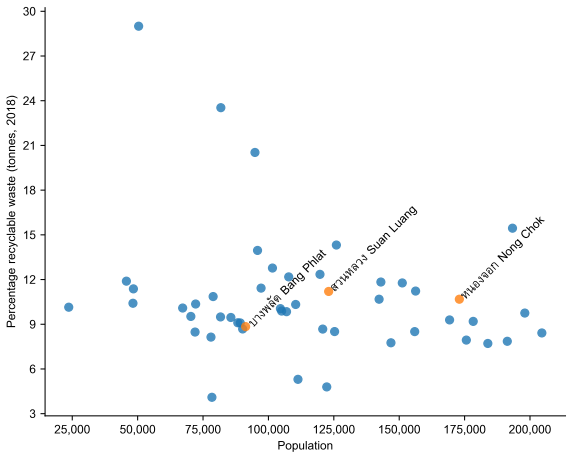


Fig. 30: Scatterplot of annual recyclable waste (tonnes) by population for districts.

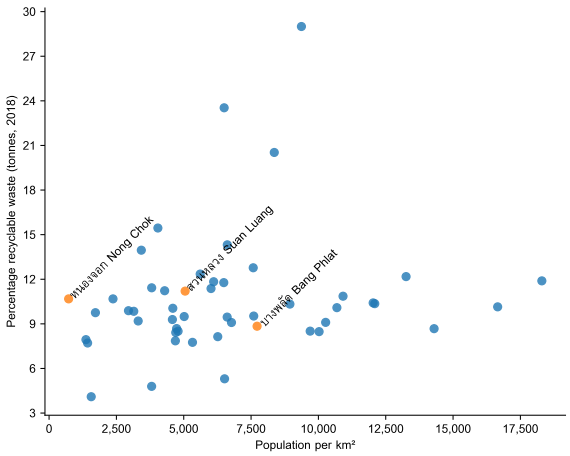


Fig. 31: Scatterplot of annual recyclable waste (tonnes) by population density for districts.

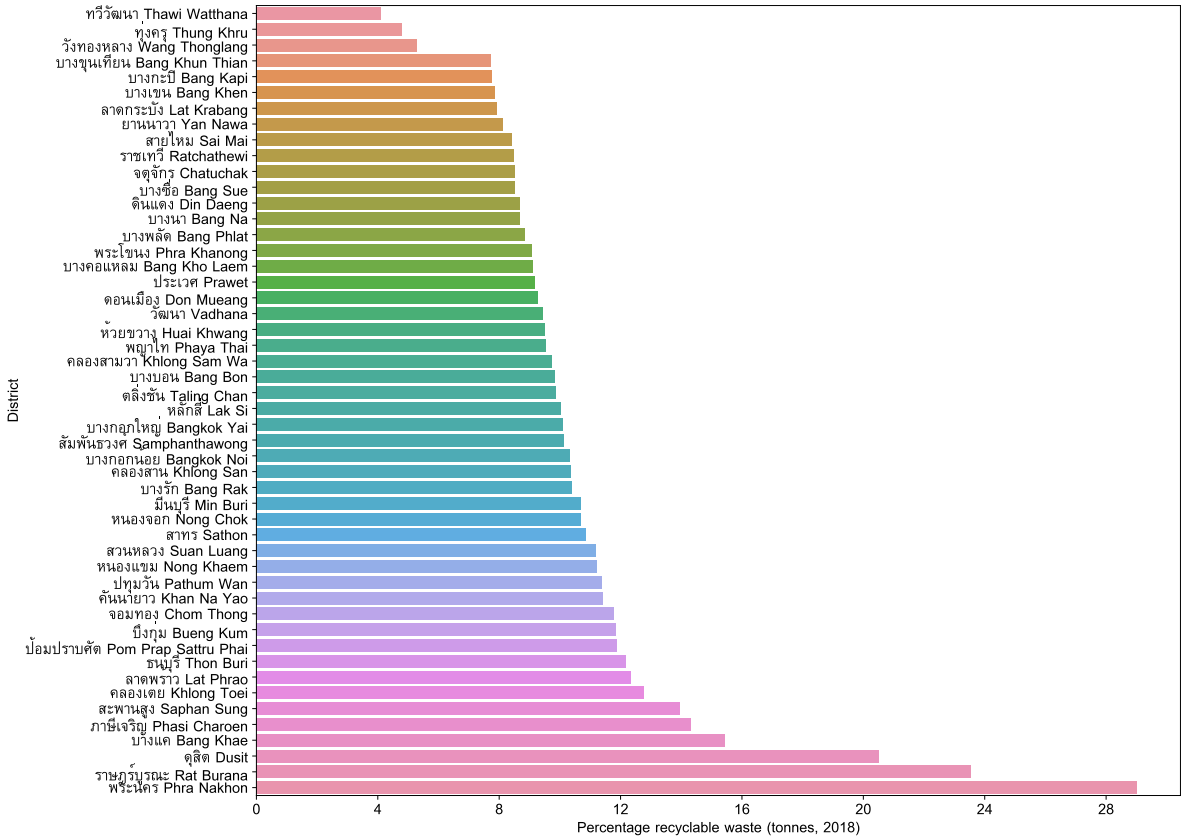


Fig. 32: Districts ranked in ascending order by annual recyclable waste (tonnes) with regard to percentage recyclable waste (tonnes, 2018).

Dataset: Hazardous waste

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `Department of Environment, BMA`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190911`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20200507/Hazardous waste segregation 2018-kn81519pter.xlsx`

Annual hazardous waste (kg, 2018)

The amount of hazardous waste segregation (kg) at waste transfer stations during 2018 was recorded for each district.

Aligns with Sustainable Development Goals: 11, 13.

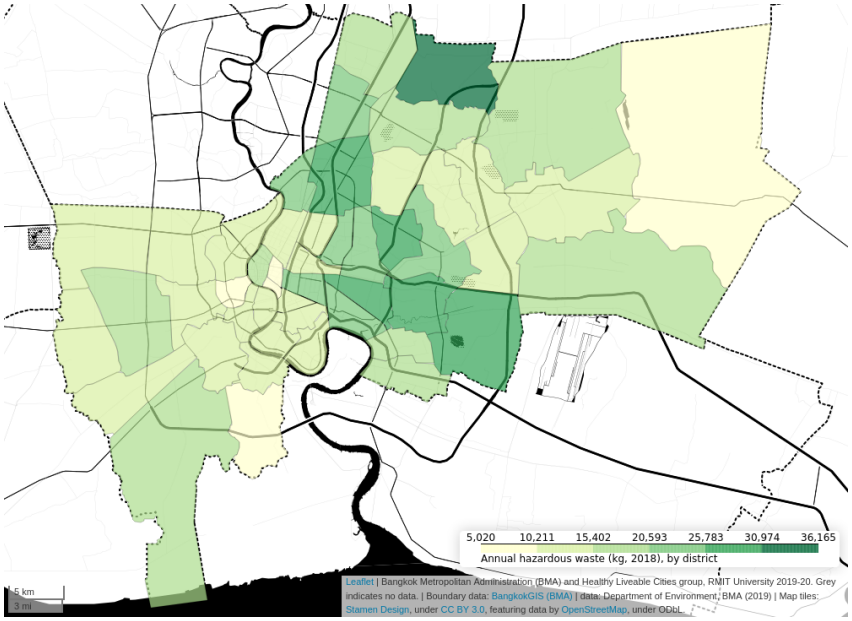


Fig. 33: Annual hazardous waste (kg, 2018), by district

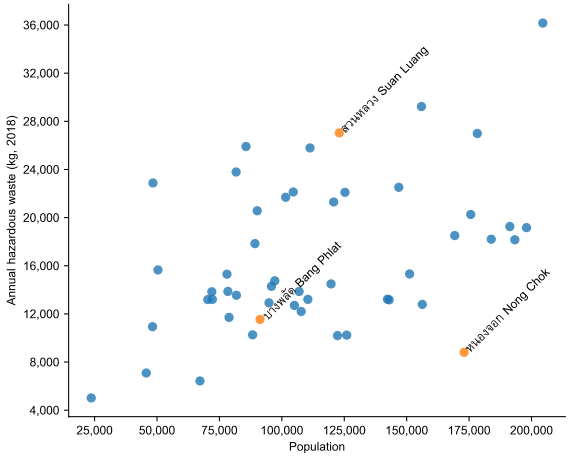


Fig. 34: Scatterplot of Hazardous waste segregation (kg) by population for districts.

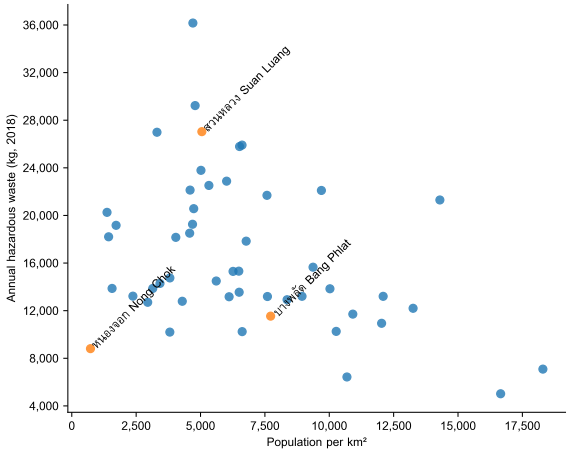


Fig. 35: Scatterplot of Hazardous waste segregation (kg) by population density for districts.

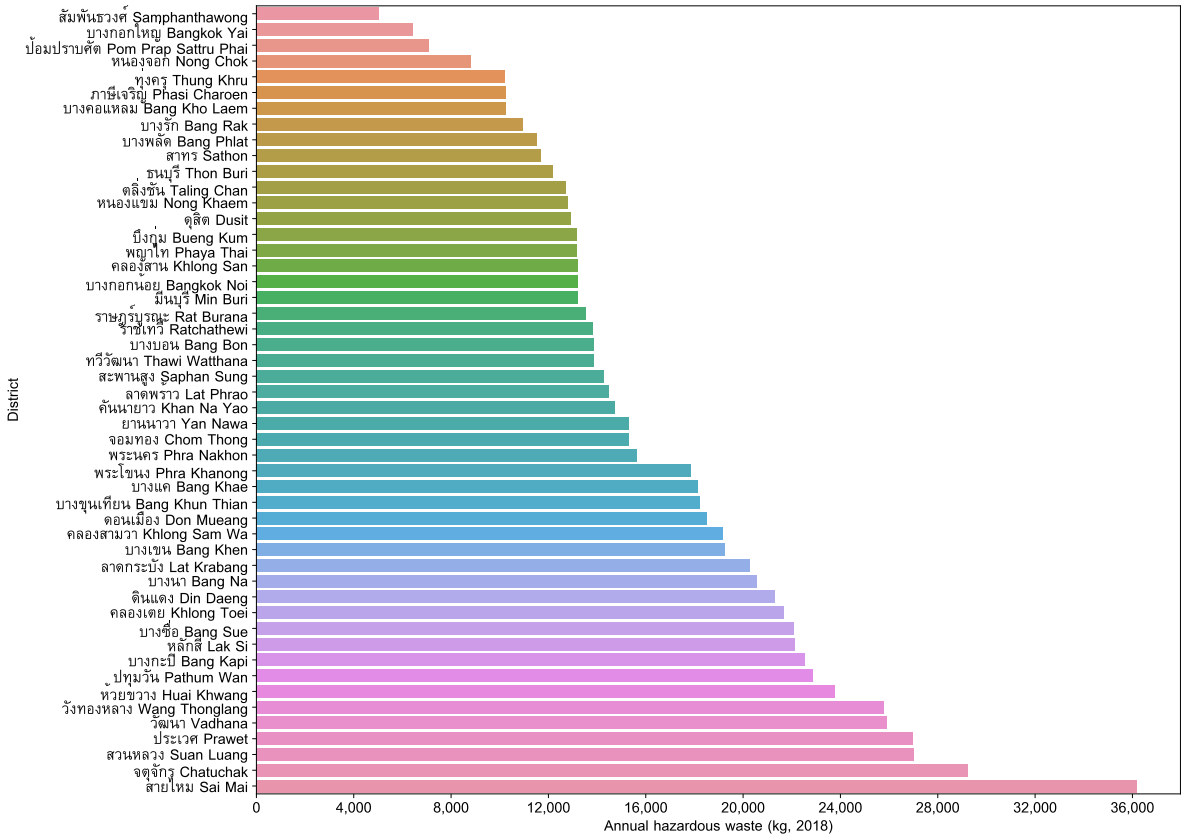


Fig. 36: Districts ranked in ascending order by hazardous waste segregation (kg) with regard to annual hazardous waste (kg, 2018).

Percentage hazardous waste (2018)

The percentage of total waste (solid and hazardous) taken to waste transfer stations during 2018 that was hazardous was recorded for each district.

Aligns with Sustainable Development Goals: 11, 13.

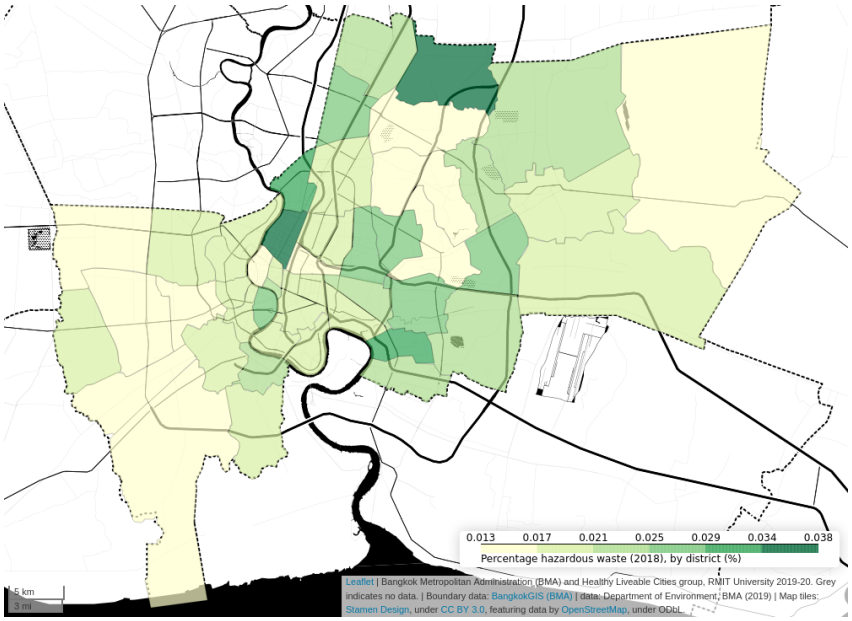


Fig. 37: Percentage hazardous waste (2018), by district

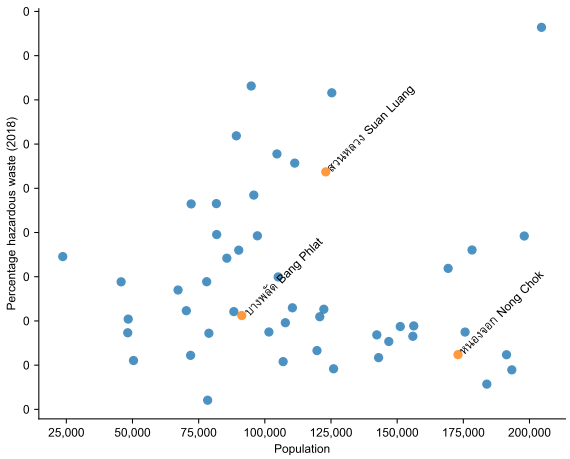


Fig. 38: Scatterplot of Hazardous waste segregation (tonnes) by population for districts.

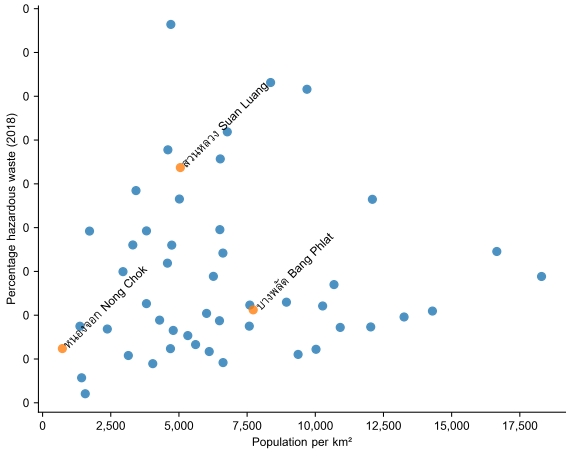


Fig. 39: Scatterplot of Hazardous waste segregation (tonnes) by population density for districts.

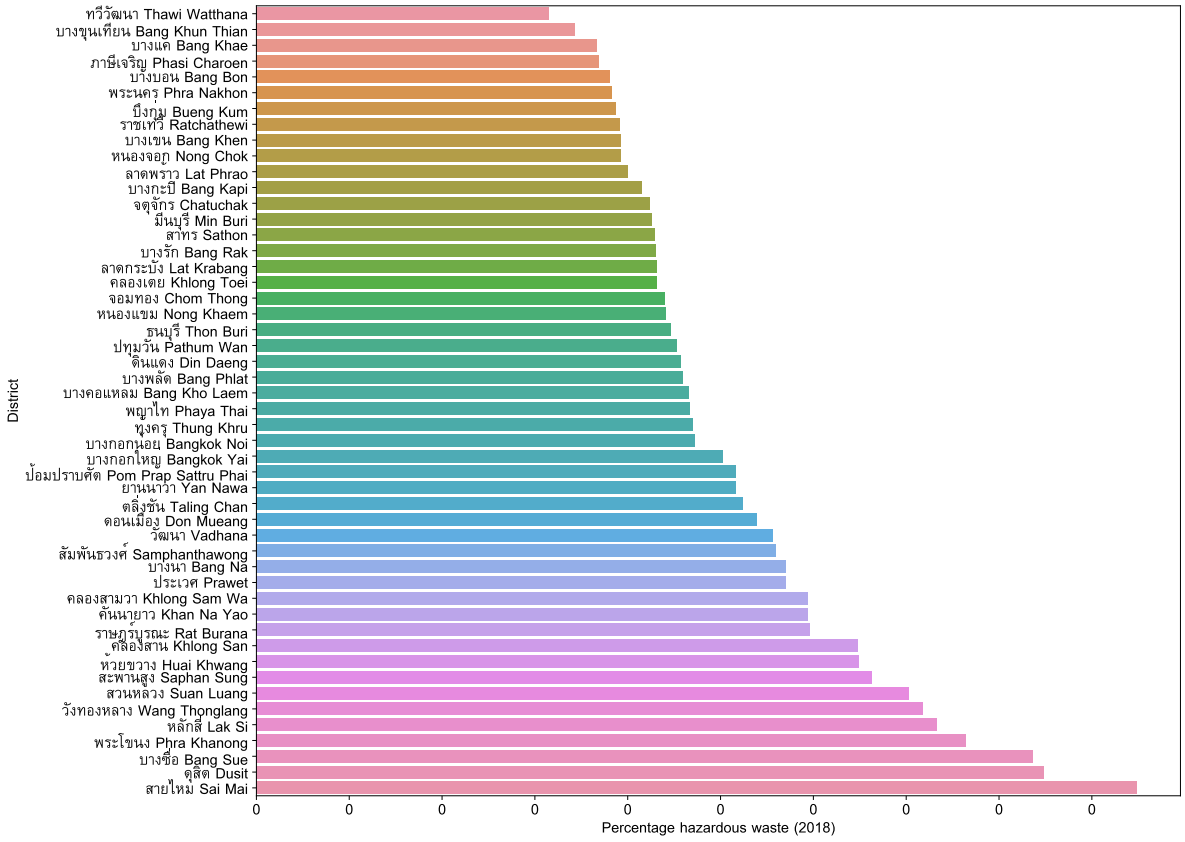


Fig. 40: Districts ranked in ascending order by hazardous waste segregation (tonnes) with regard to percentage hazardous waste (2018).

2.3.4 No flooding

ไม่มีน้ำท่วม

Floods means large amounts of water overflowing into normal land.

Dataset: Flood risk

Data at subdistrict level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `Department of Drainage and Sewerage , BMA`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190809`

Licence: `none specified`

Date type: `float`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190809/transfer_1673010_files_4a5fe795/BKK indicator_flood_kn 63019.xlsx`

Main road flood area location count (2018)

The count of main road flood areas associated with each analysis area was recorded.

Aligns with Sustainable Development Goals: 11, 13.

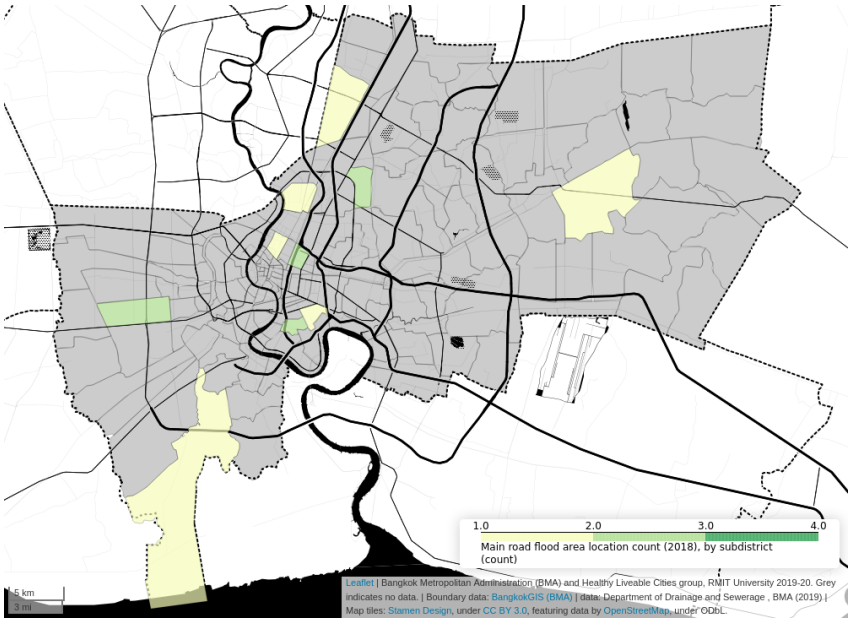


Fig. 41: Main road flood area location count (2018), by subdistrict

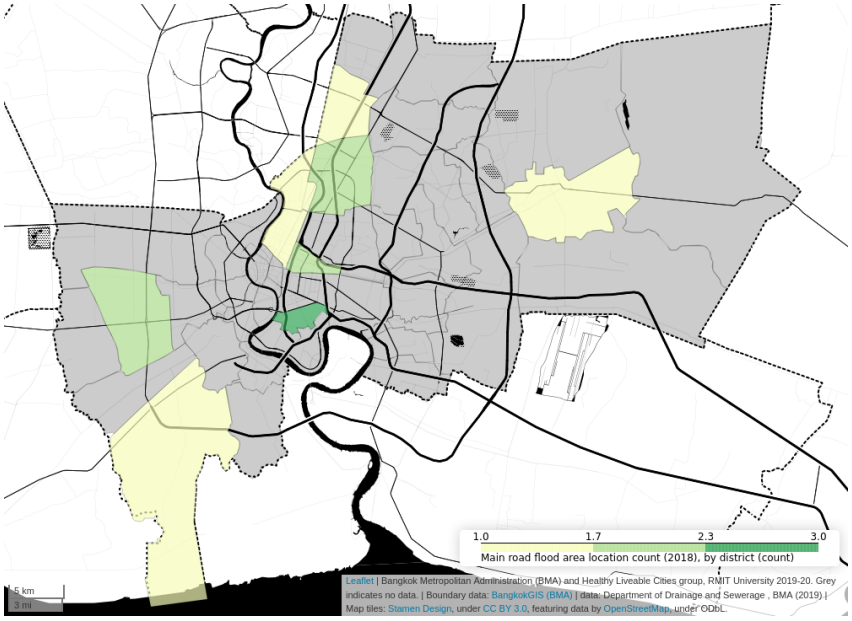


Fig. 42: Main road flood area location count (2018), by district

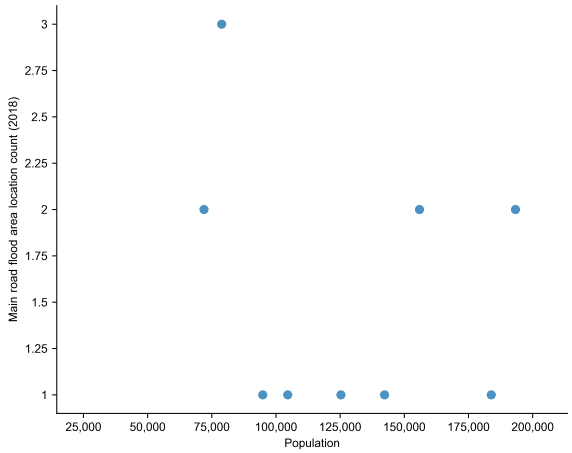


Fig. 43: Scatterplot of main road flood locations by population for districts.

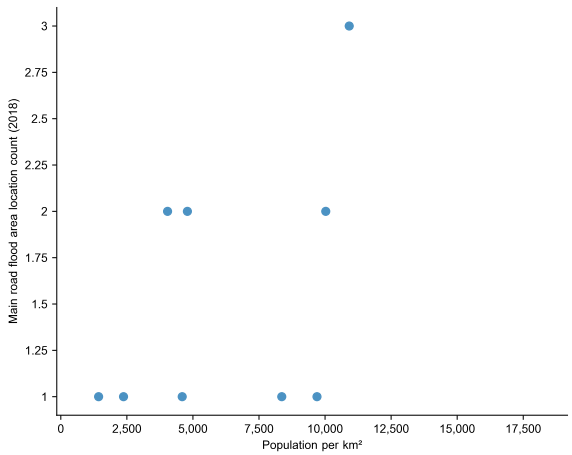


Fig. 44: Scatterplot of main road flood locations by population density for districts.

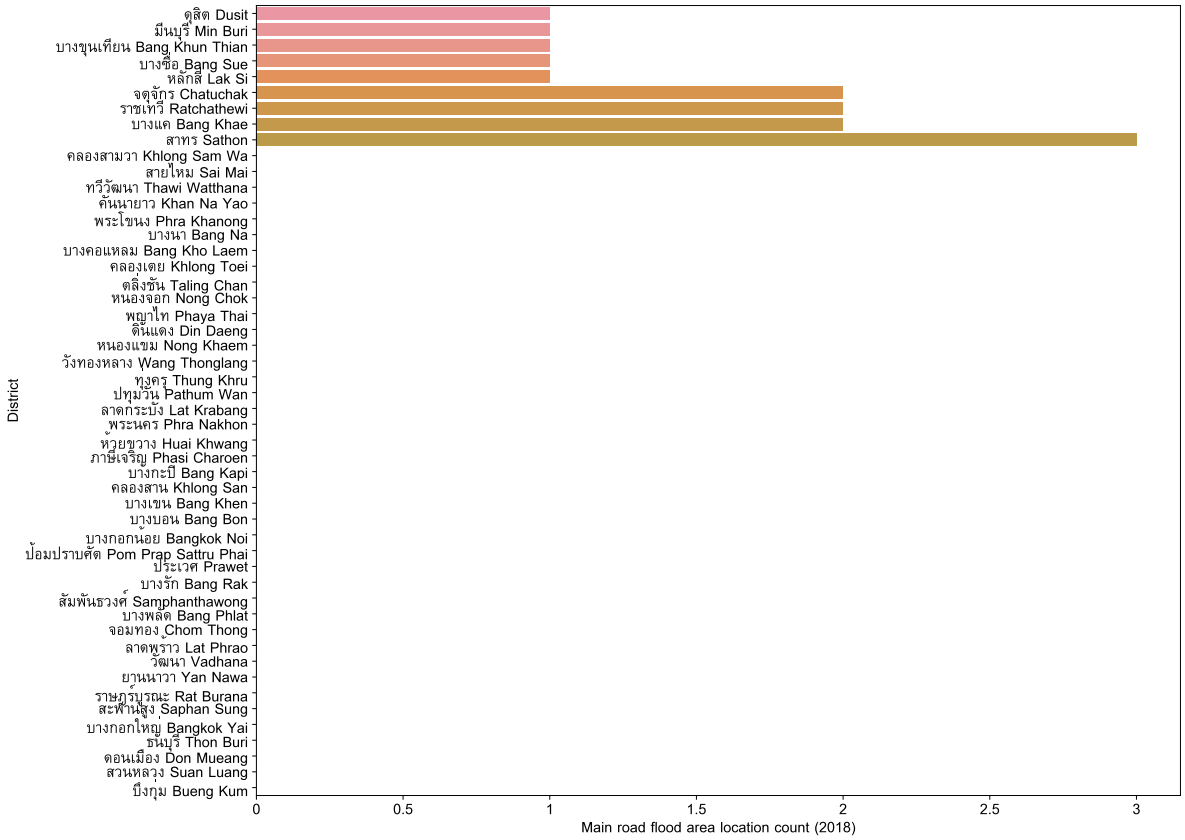


Fig. 45: Districts ranked in ascending order by main road flood locations with regard to main road flood area location count (2018).

Main road flood area location count (2018) per km^2

The count of main road flood areas associated with each analysis area was recorded. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 11, 13.

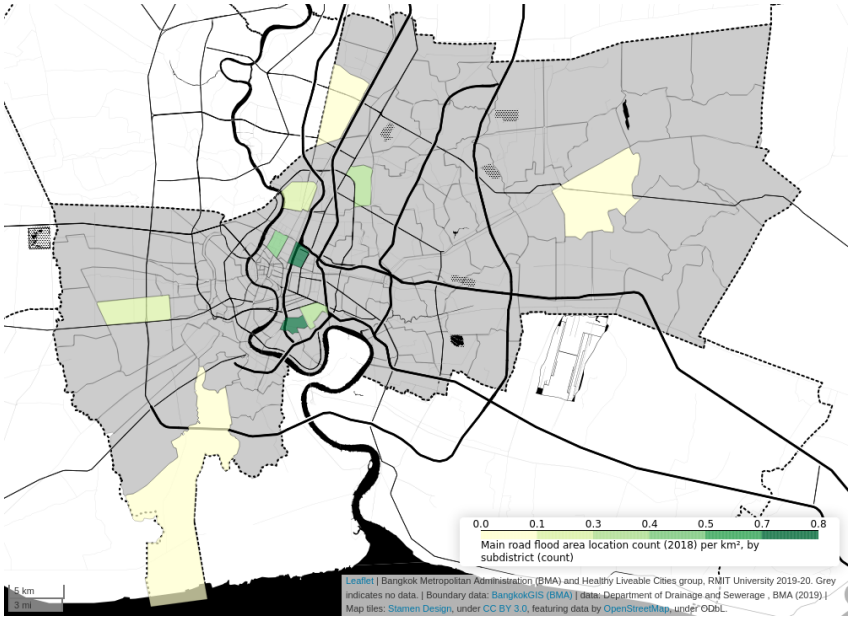


Fig. 46: Main road flood area location count (2018) per km^2, by subdistrict

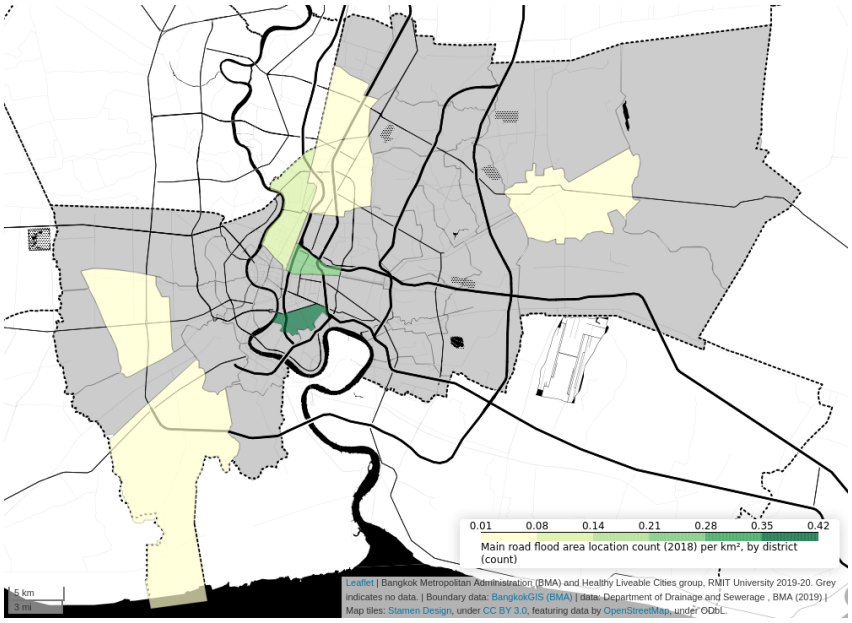


Fig. 47: Main road flood area location count (2018) per km^2, by district

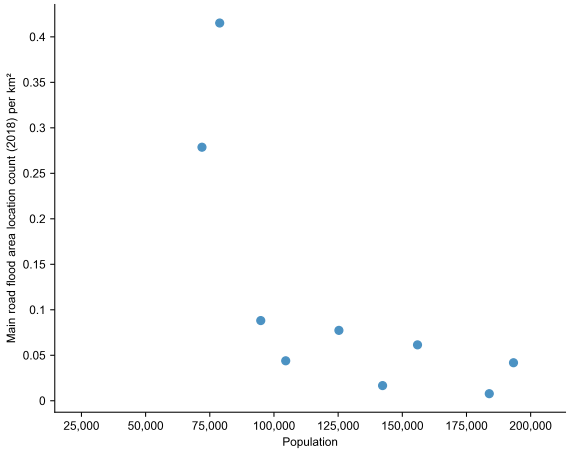


Fig. 48: Scatterplot of main road flood locations by population for districts.

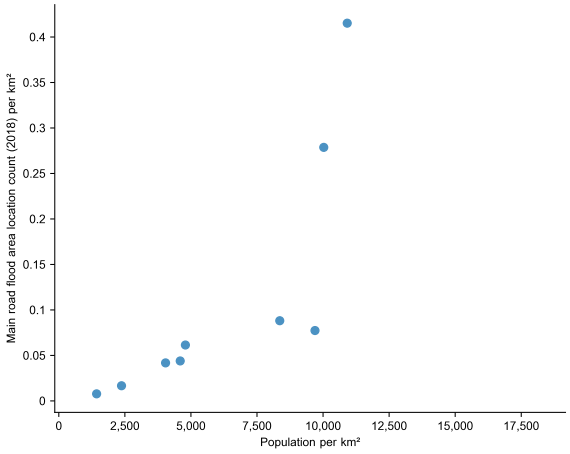


Fig. 49: Scatterplot of main road flood locations by population density for districts.

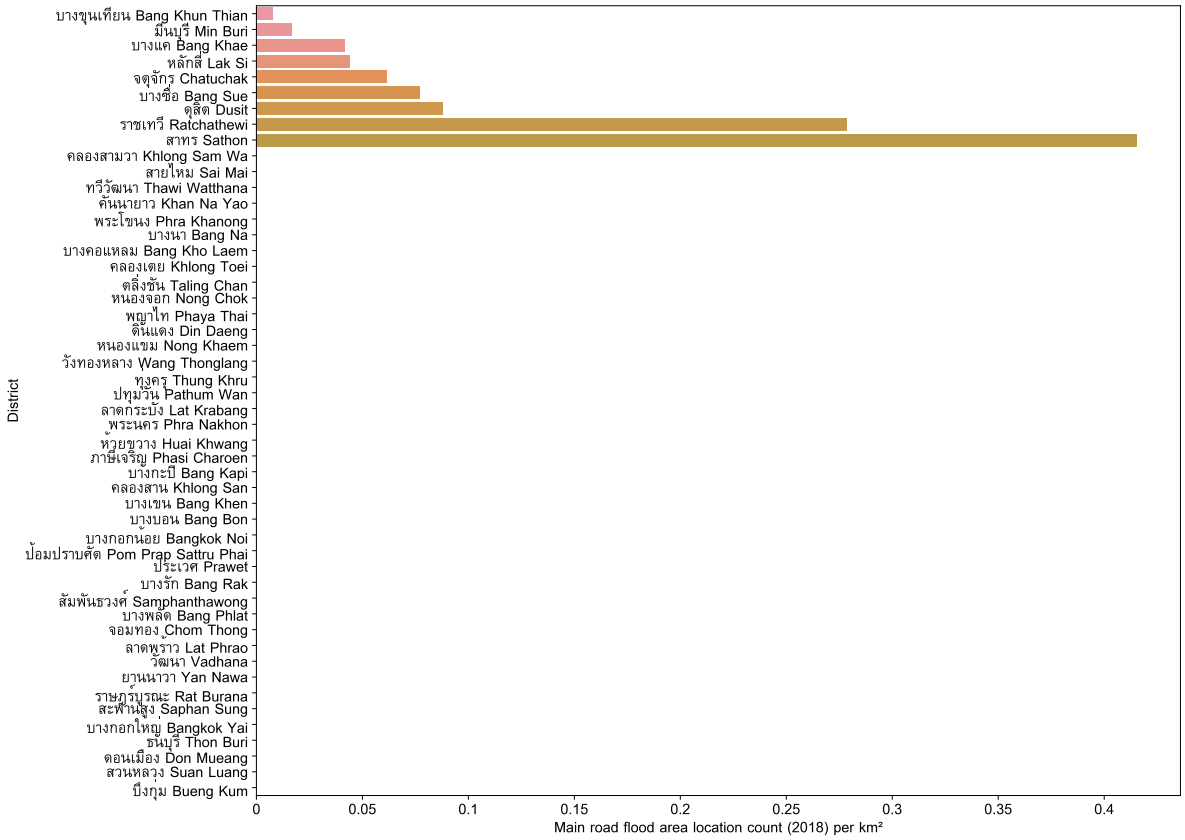


Fig. 50: Districts ranked in ascending order by main road flood locations with regard to main road flood area location count (2018) per km^2.

Main road flood area location count (2018) per 10,000 population

The count of main road flood areas associated with each analysis area was recorded. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 11, 13.

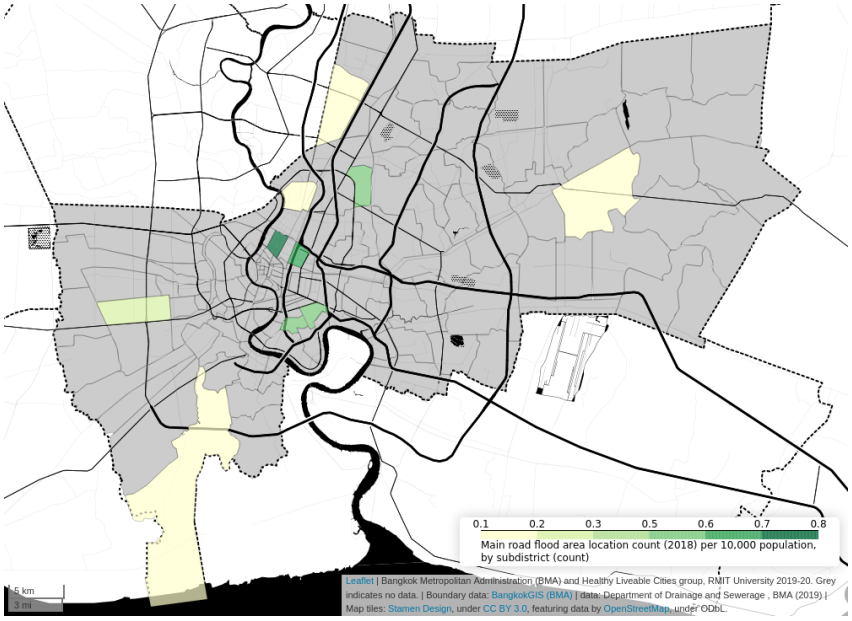


Fig. 51: Main road flood area location count (2018) per 10,000 population, by subdistrict

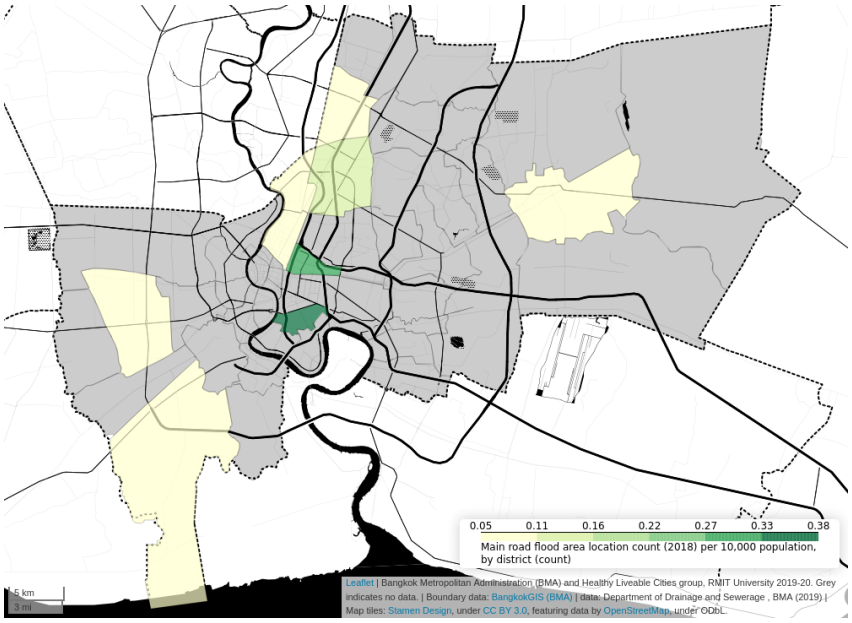


Fig. 52: Main road flood area location count (2018) per 10,000 population, by district

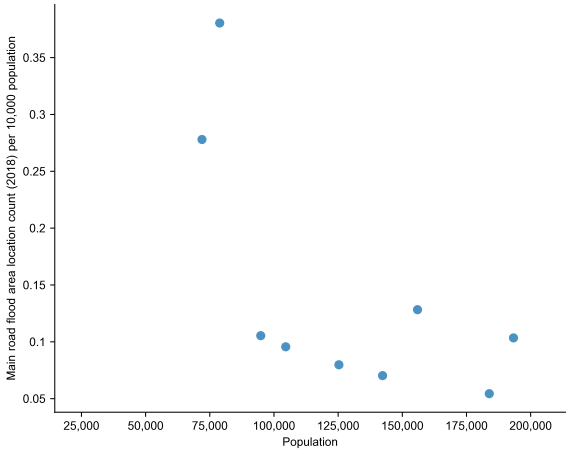


Fig. 53: Scatterplot of main road flood locations by population for districts.

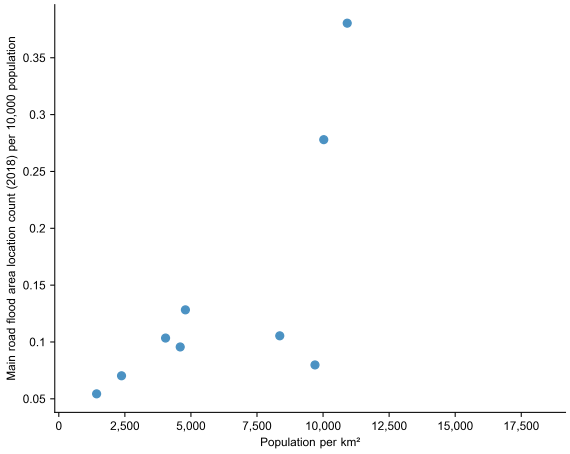


Fig. 54: Scatterplot of main road flood locations by population density for districts.

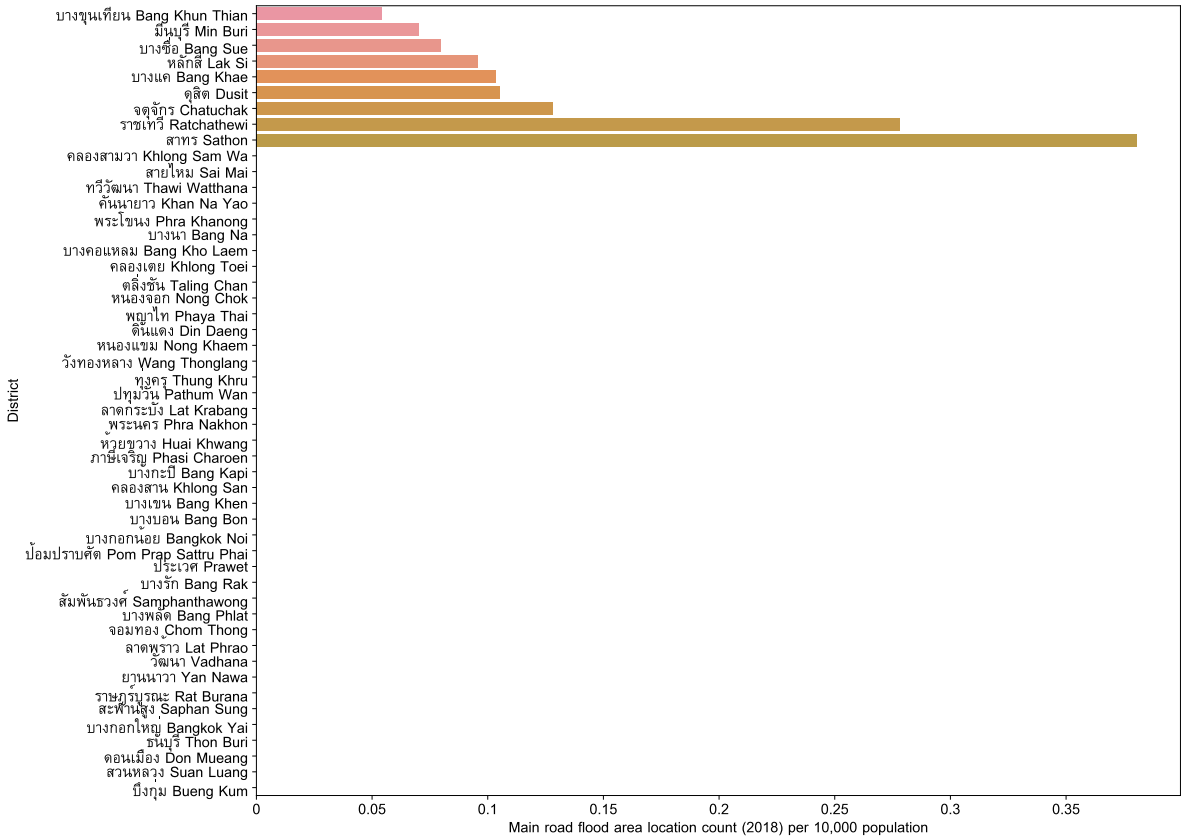


Fig. 55: Districts ranked in ascending order by main road flood locations with regard to main road flood area location count (2018) per 10,000 population.

Main road flood area location count (2018) per 10,000 household

The count of main road flood areas associated with each analysis area was recorded. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 11, 13.

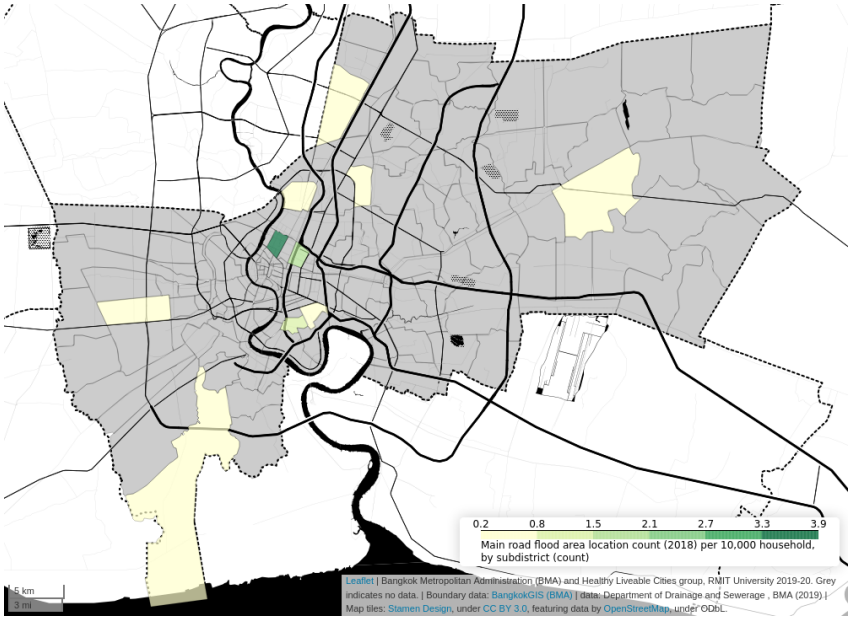


Fig. 56: Main road flood area location count (2018) per 10,000 household, by subdistrict

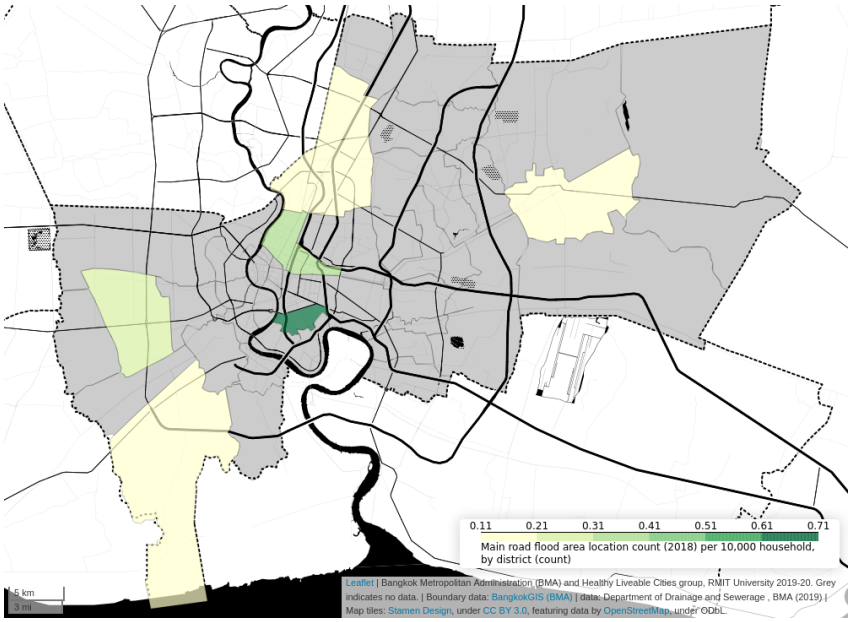


Fig. 57: Main road flood area location count (2018) per 10,000 household, by district

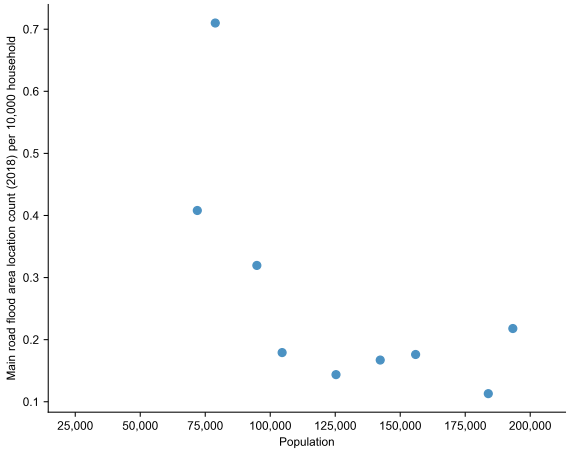


Fig. 58: Scatterplot of main road flood locations by population for districts.

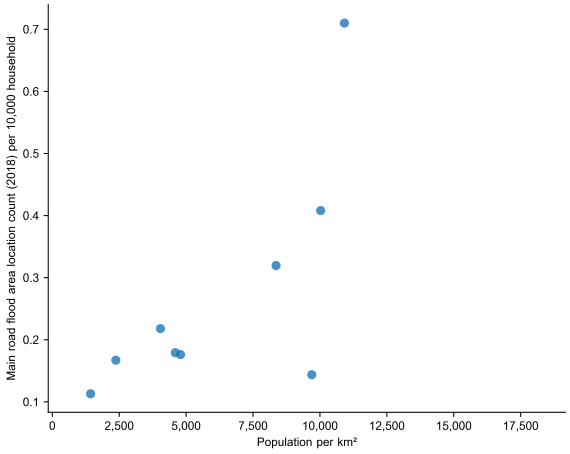


Fig. 59: Scatterplot of main road flood locations by population density for districts.

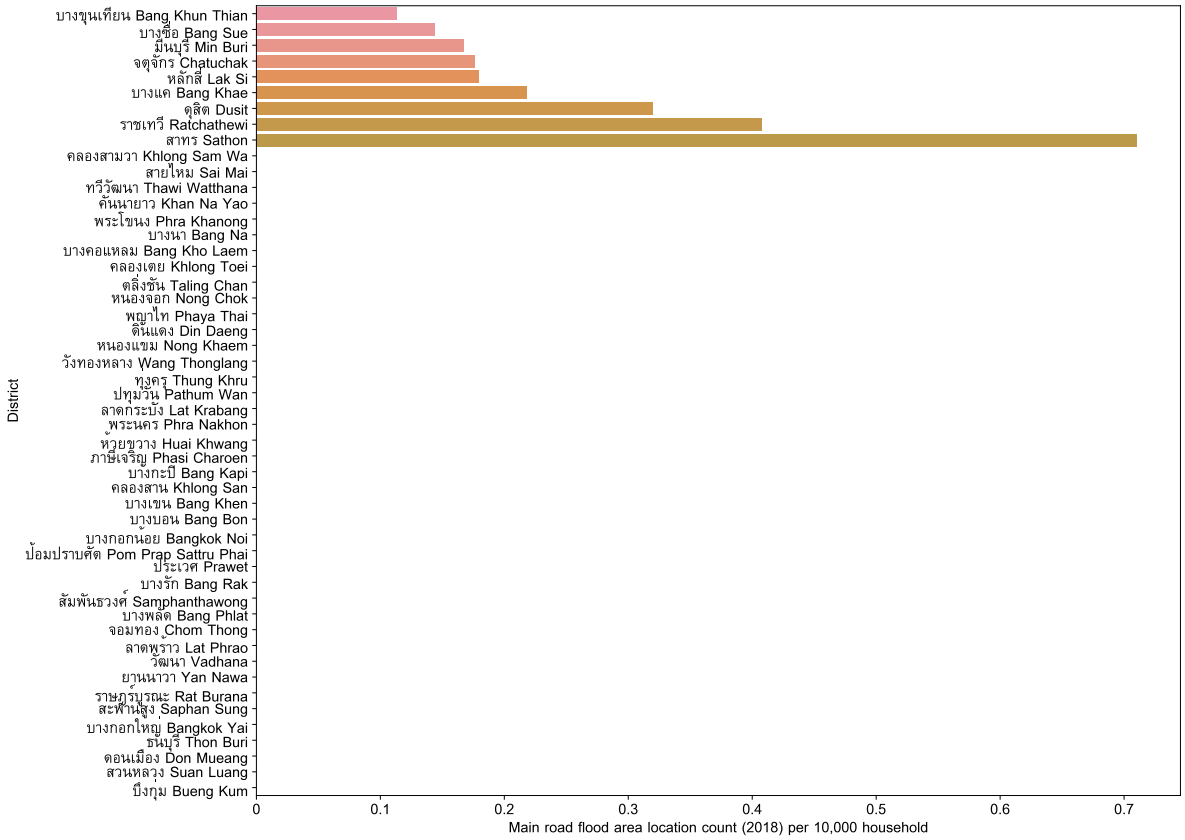


Fig. 60: Districts ranked in ascending order by main road flood locations with regard to main road flood area location count (2018) per 10,000 household.

Average days of rain (main road flood areas; 2018)

The average number of days of rain recorded for 14 main road flood areas was taken for each analysis area.

Aligns with Sustainable Development Goals: 11, 13.

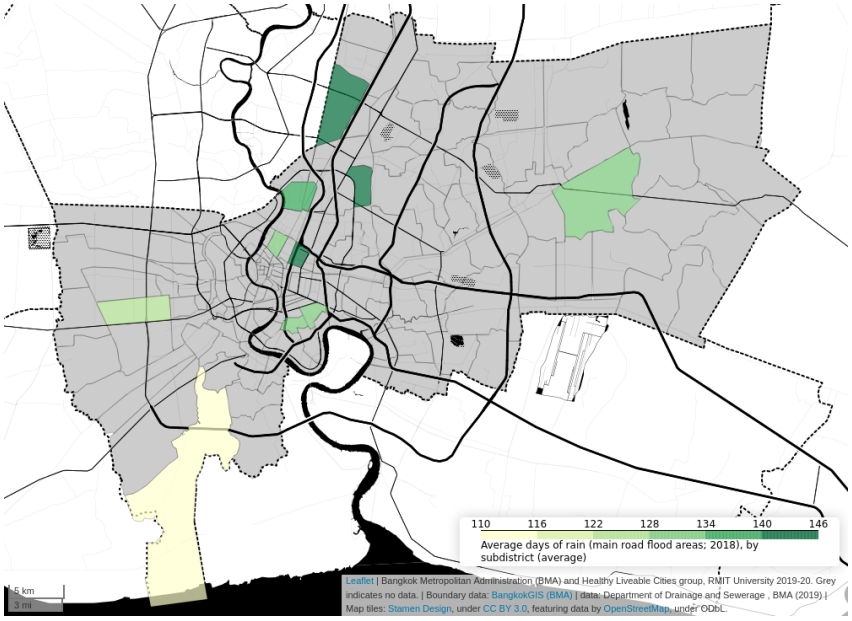


Fig. 61: Average days of rain (main road flood areas; 2018), by subdistrict

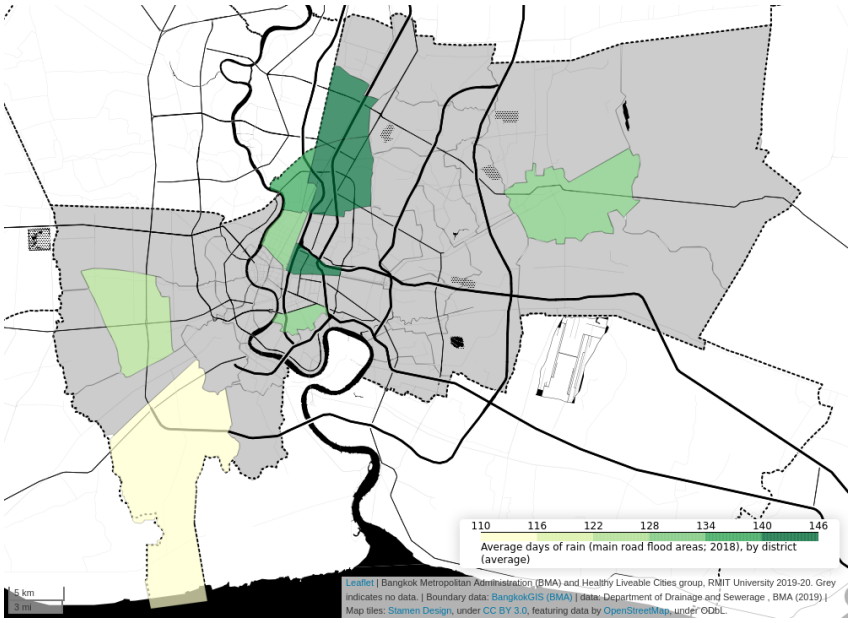


Fig. 62: Average days of rain (main road flood areas; 2018), by district

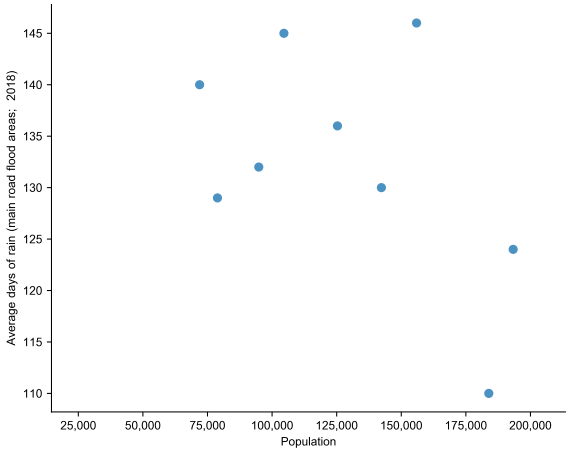


Fig. 63: Scatterplot of days of rain by population for districts.

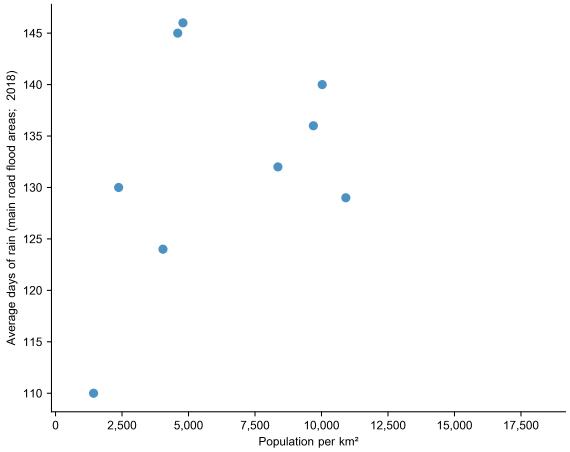


Fig. 64: Scatterplot of days of rain by population density for districts.

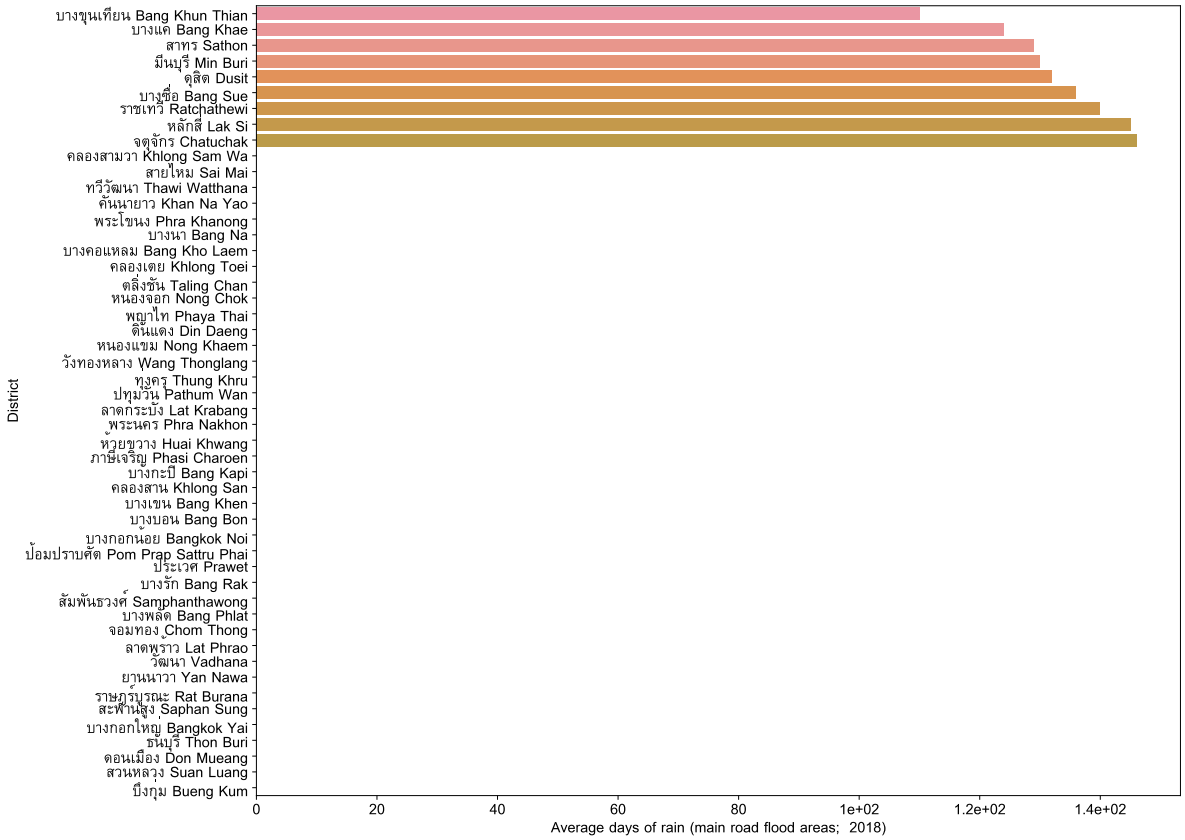


Fig. 65: Districts ranked in ascending order by days of rain with regard to average days of rain (main road flood areas; 2018).

Average maximum intensity (main road flood areas; 2018)

The average maximum intensity recorded for 14 main road flood areas was taken for each analysis area.

Aligns with Sustainable Development Goals: 11, 13.

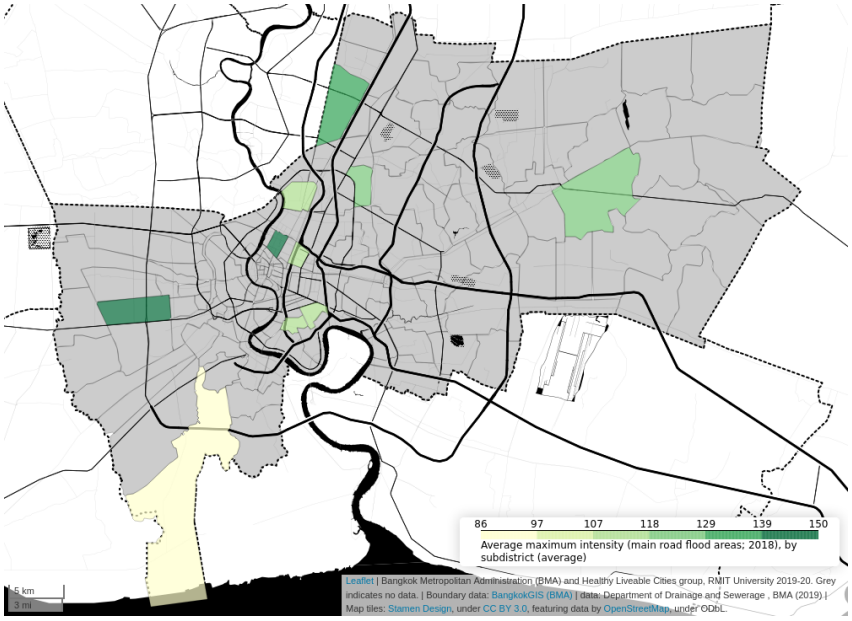


Fig. 66: Average maximum intensity (main road flood areas; 2018), by subdistrict

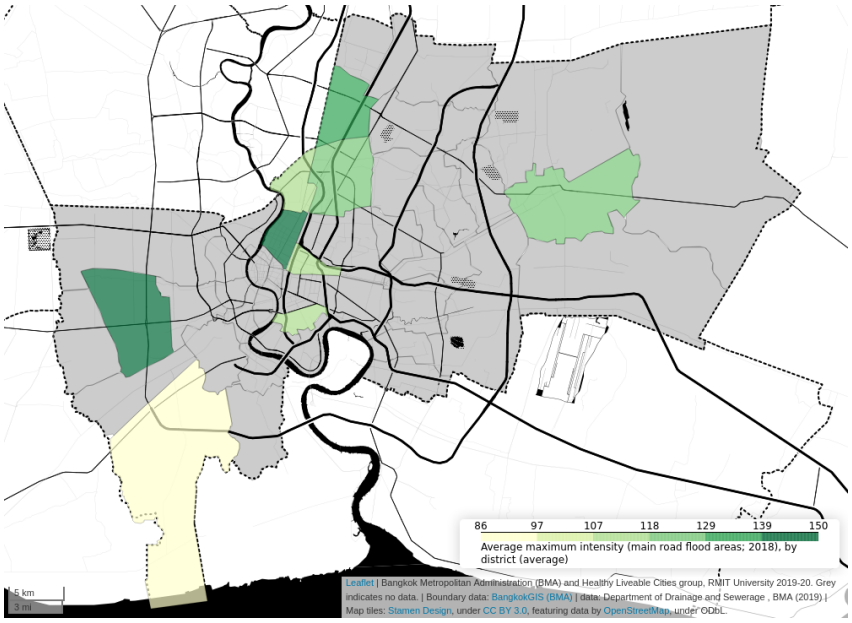


Fig. 67: Average maximum intensity (main road flood areas; 2018), by district

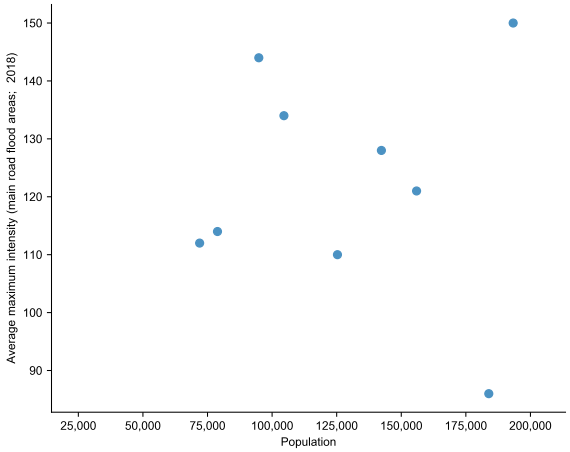


Fig. 68: Scatterplot of maximum intensity by population for districts.

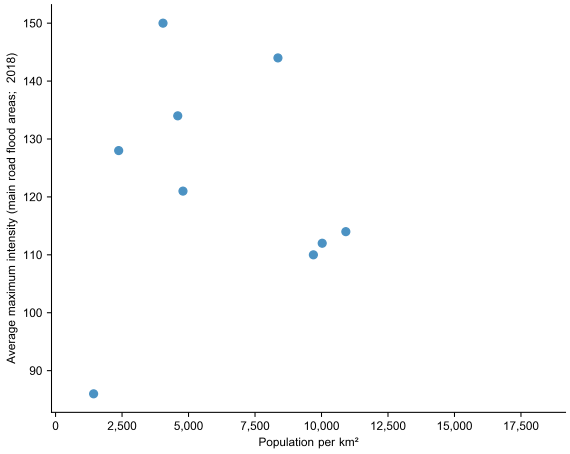


Fig. 69: Scatterplot of maximum intensity by population density for districts.

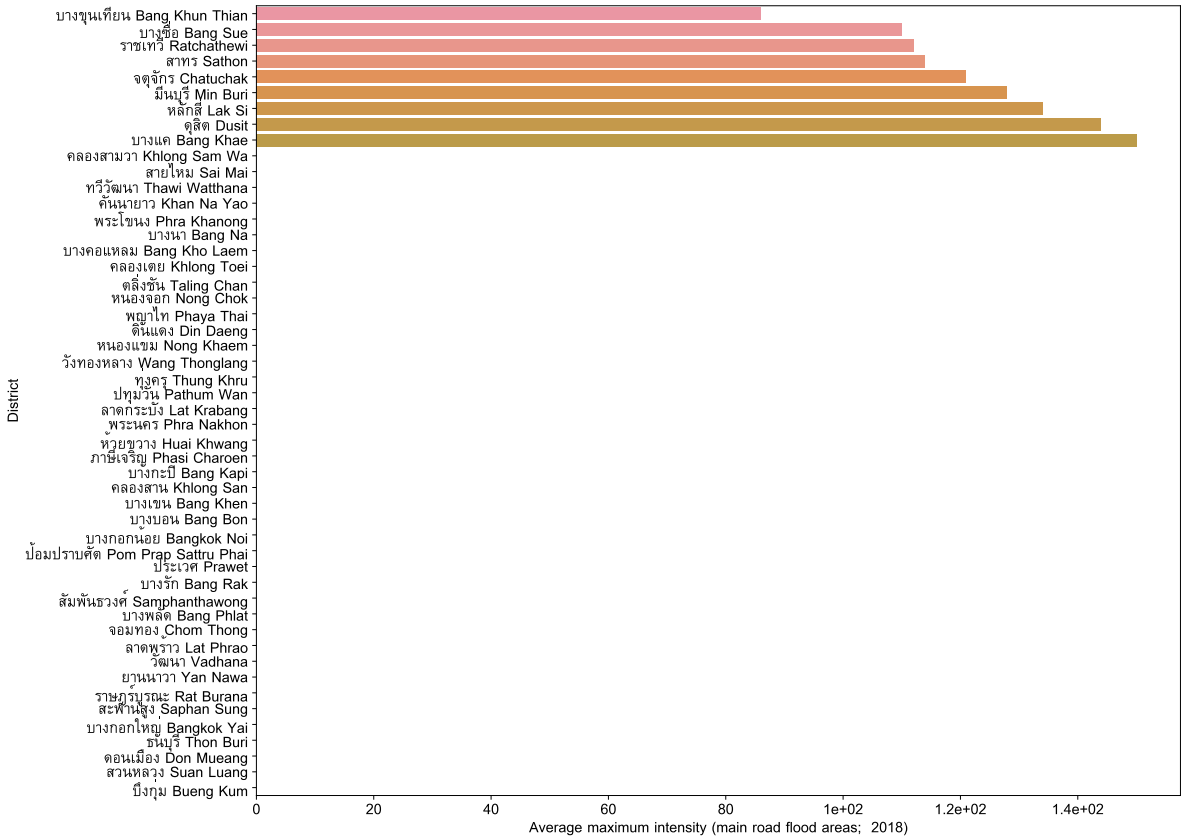


Fig. 70: Districts ranked in ascending order by maximum intensity with regard to average maximum intensity (main road flood areas; 2018).

Average days of flooding (main road flood areas; 2018)

The average number of days of flooding recorded for 14 main road flood areas was taken for each analysis area.

Aligns with Sustainable Development Goals: 11, 13.

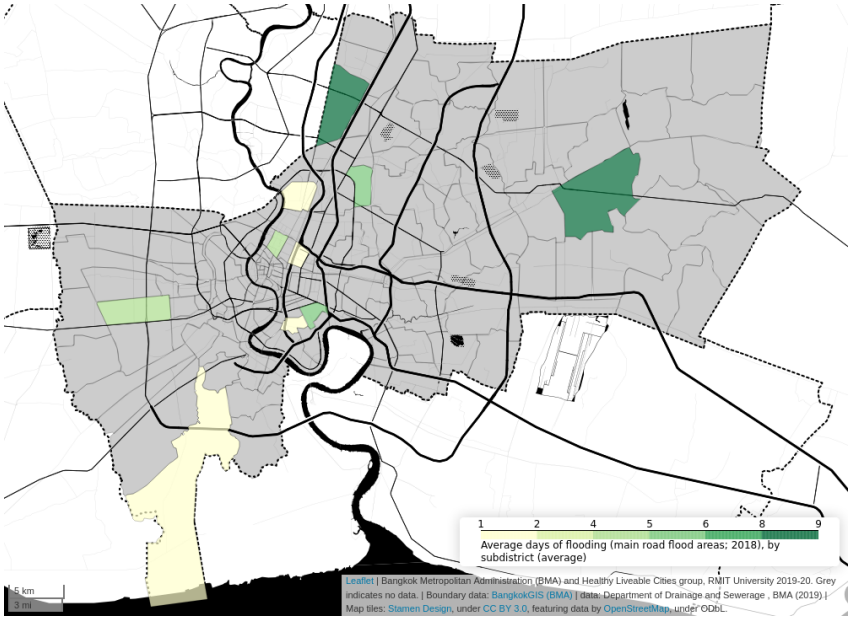


Fig. 71: Average days of flooding (main road flood areas; 2018), by subdistrict

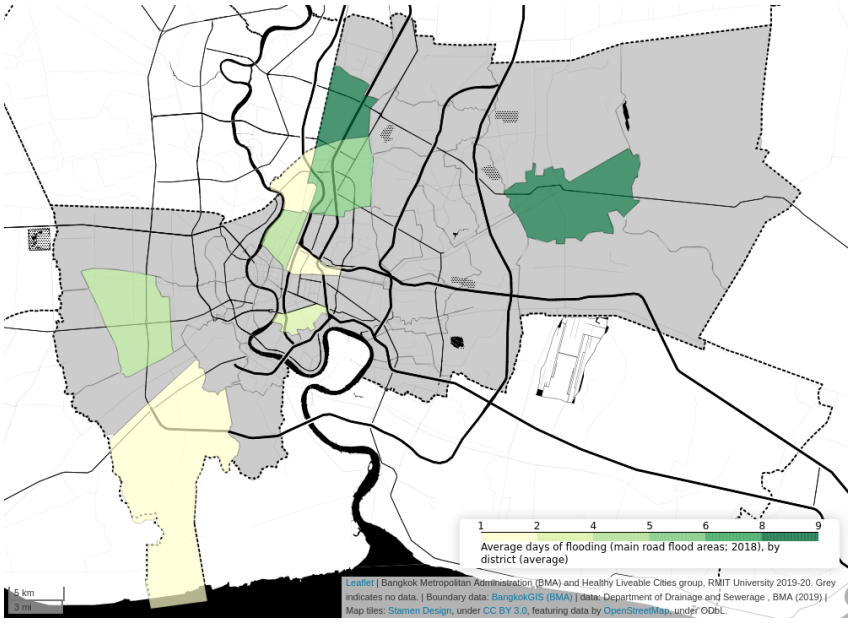


Fig. 72: Average days of flooding (main road flood areas; 2018), by district

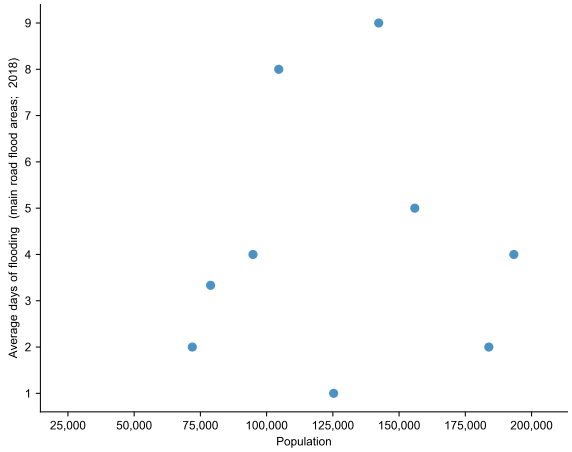


Fig. 73: Scatterplot of days of flooding by population for districts.

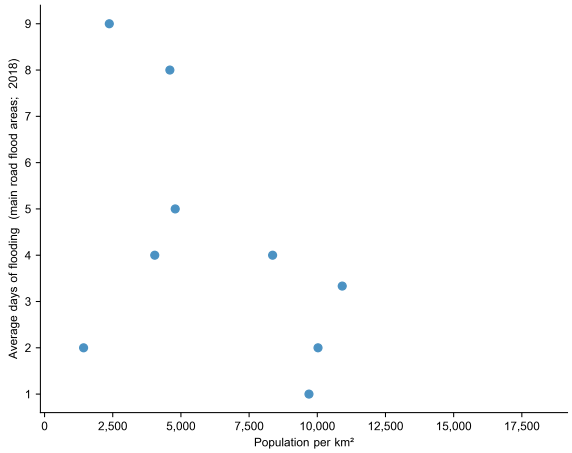


Fig. 74: Scatterplot of days of flooding by population density for districts.

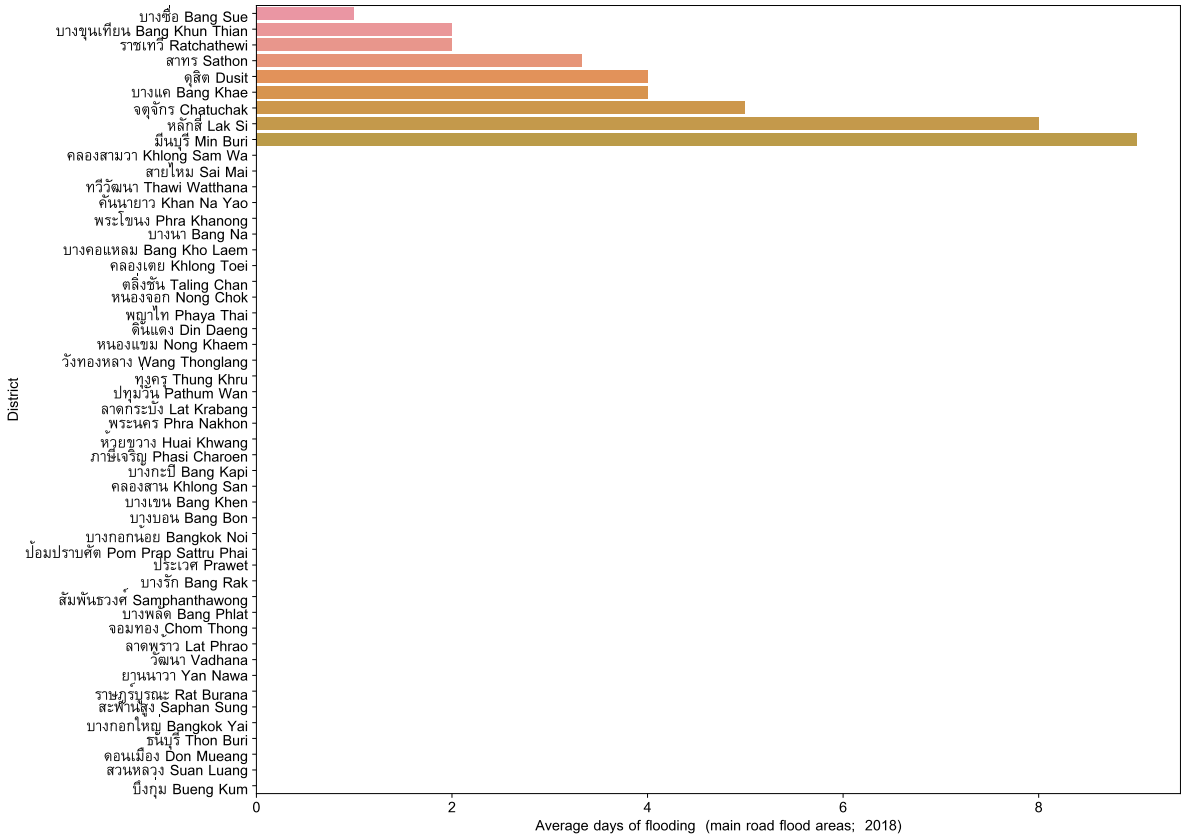


Fig. 75: Districts ranked in ascending order by days of flooding with regard to average days of flooding (main road flood areas; 2018).

Vulnerable flood area count (2018)

The count of vulnerable flood areas associated with each analysis area was recorded.

Aligns with Sustainable Development Goals: 11, 13.

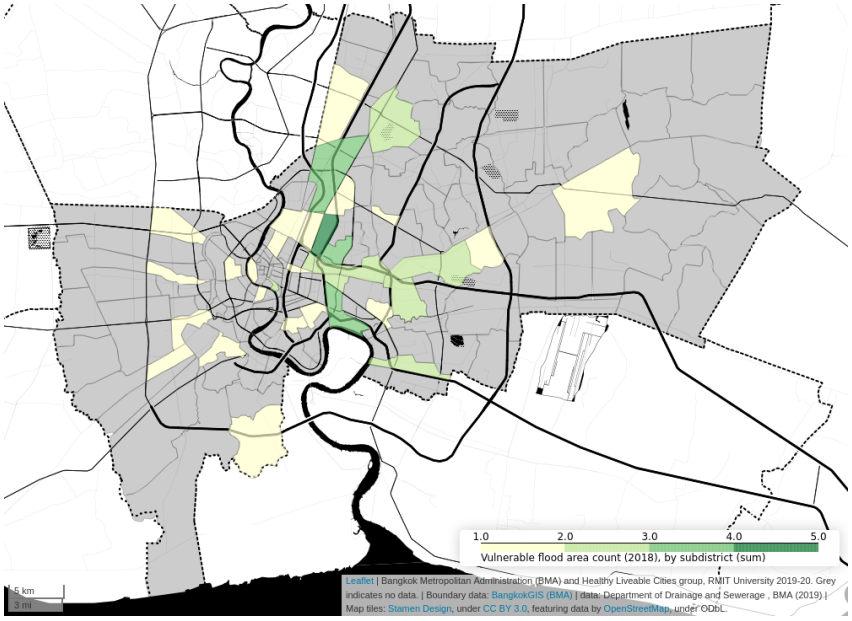


Fig. 76: Vulnerable flood area count (2018), by subdistrict

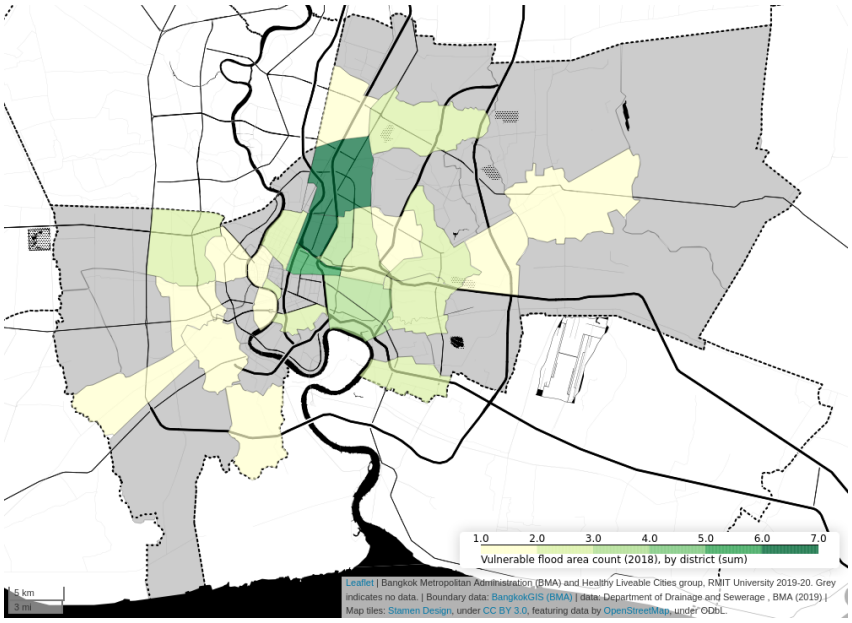


Fig. 77: Vulnerable flood area count (2018), by district

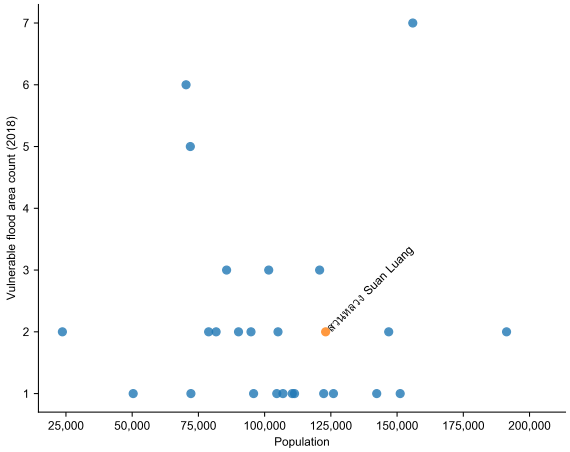


Fig. 78: Scatterplot of flood risk locations by population for districts.

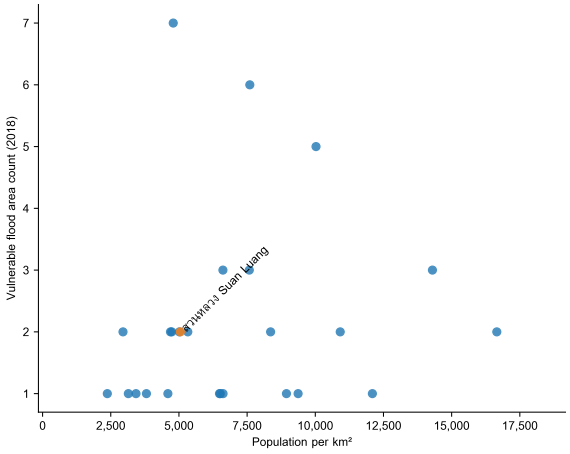


Fig. 79: Scatterplot of flood risk locations by population density for districts.

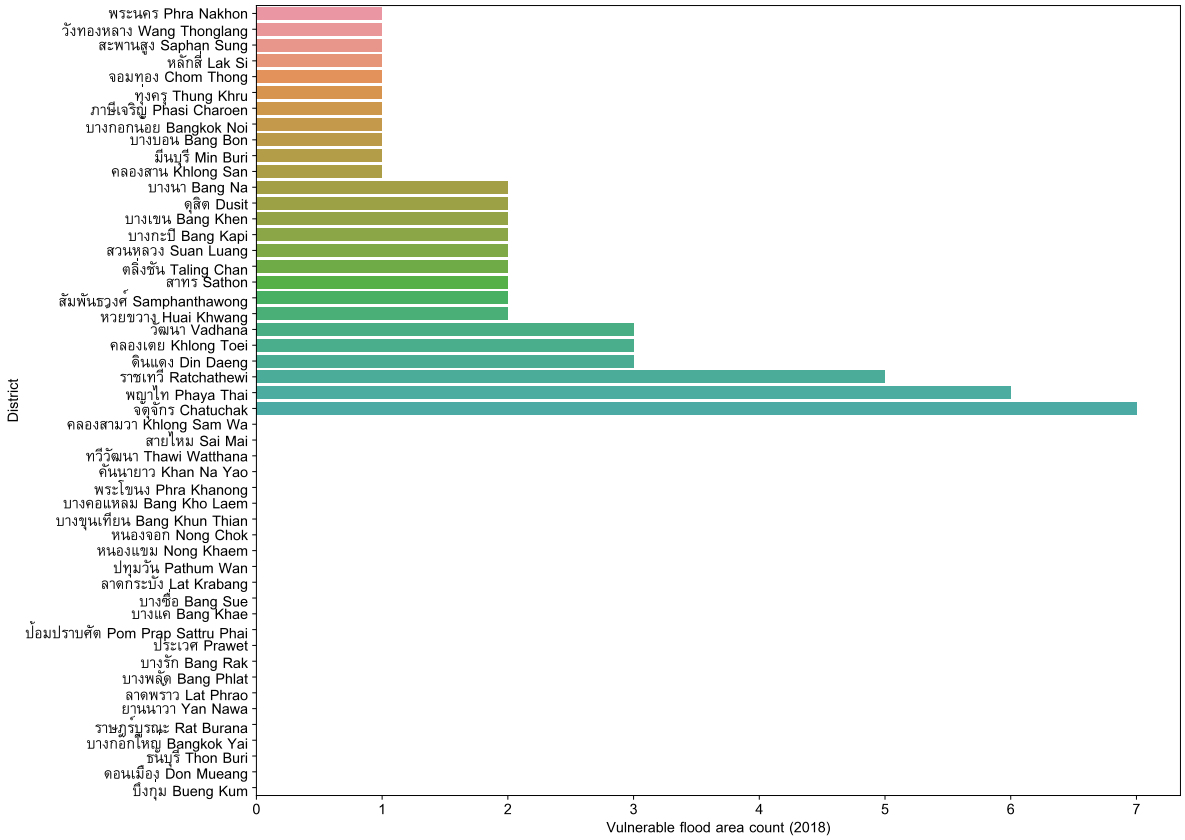


Fig. 80: Districts ranked in ascending order by flood risk locations with regard to vulnerable flood area count (2018).

Vulnerable flood area count (2018) per km^2

The count of vulnerable flood areas associated with each analysis area was recorded. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 11, 13.

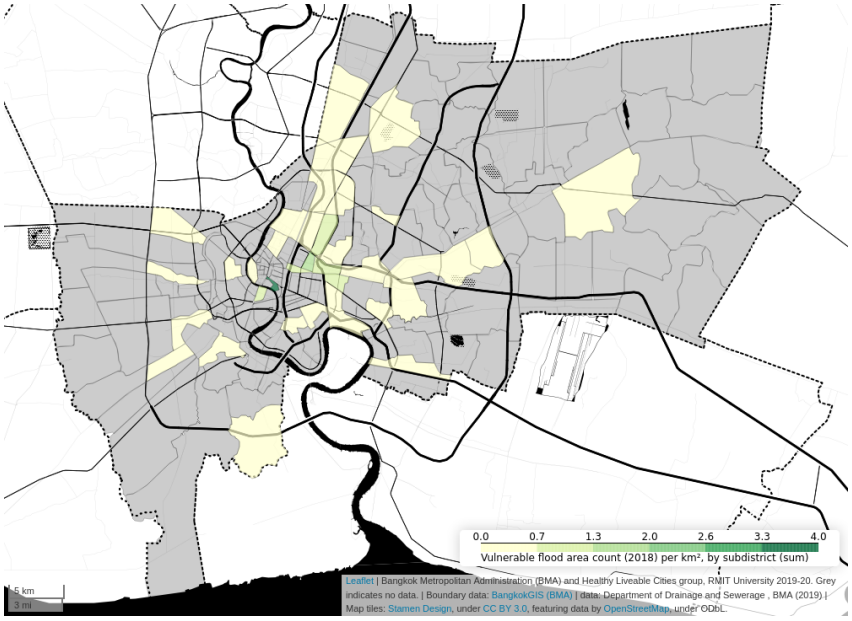


Fig. 81: Vulnerable flood area count (2018) per km^2, by subdistrict

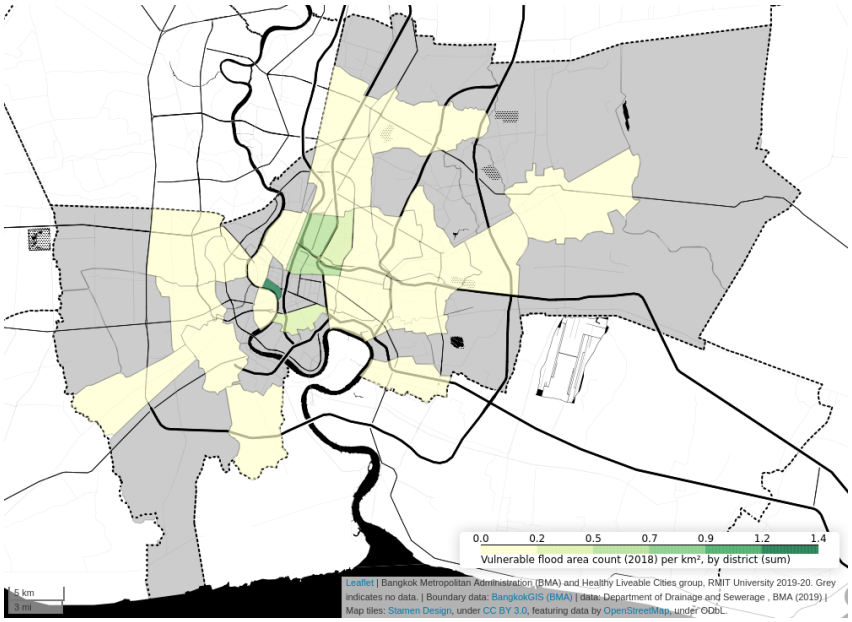


Fig. 82: Vulnerable flood area count (2018) per km^2, by district

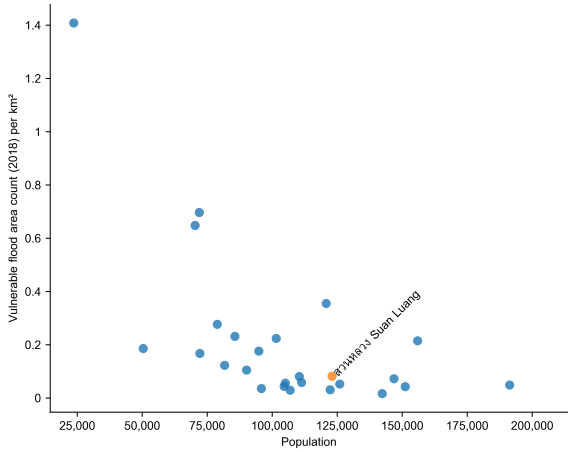


Fig. 83: Scatterplot of flood risk locations by population for districts.

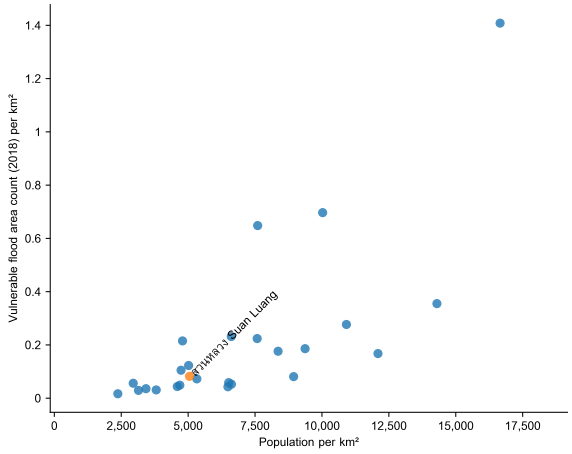


Fig. 84: Scatterplot of flood risk locations by population density for districts.

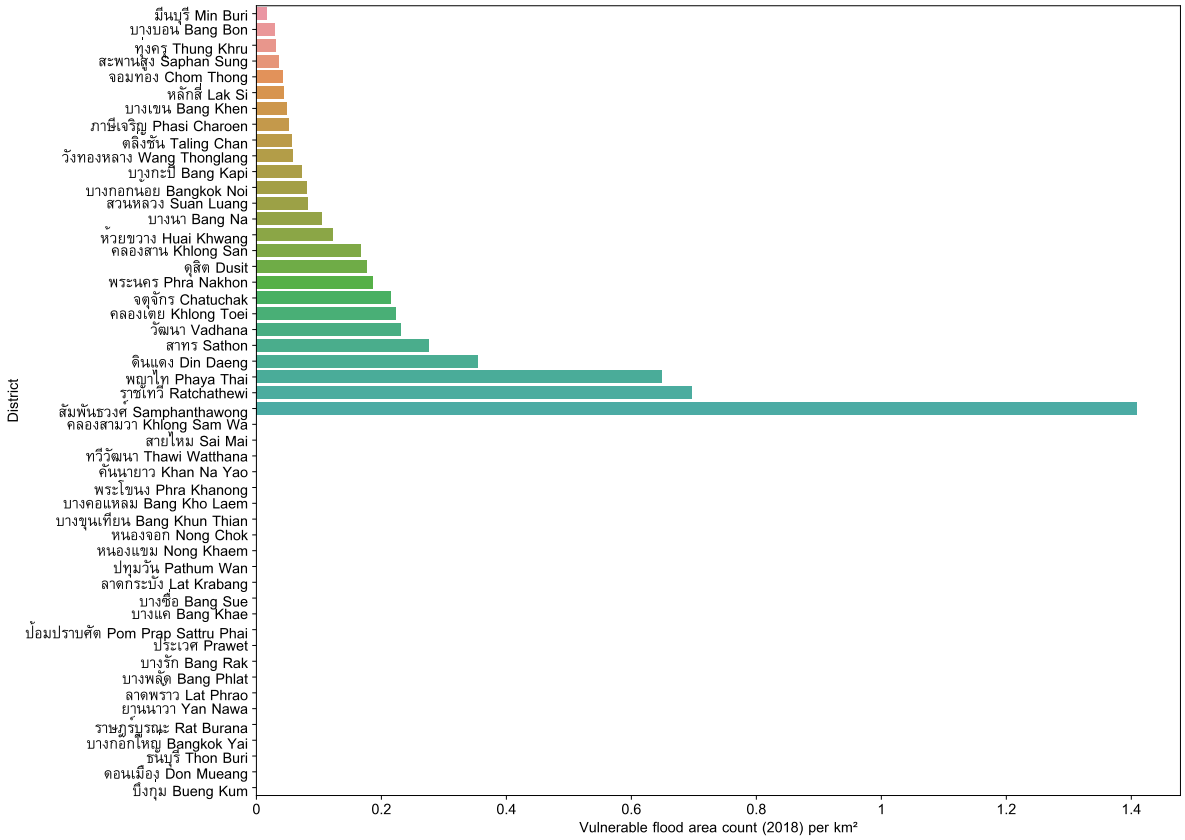


Fig. 85: Districts ranked in ascending order by flood risk locations with regard to vulnerable flood area count (2018) per km^2.

Vulnerable flood area count (2018) per 10,000 population

The count of vulnerable flood areas associated with each analysis area was recorded. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 11, 13.

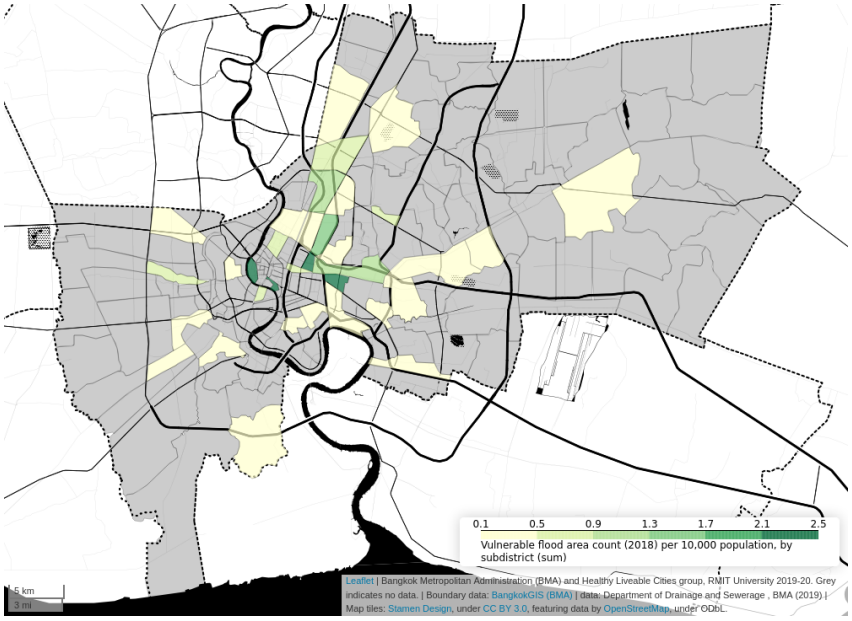


Fig. 86: Vulnerable flood area count (2018) per 10,000 population, by subdistrict

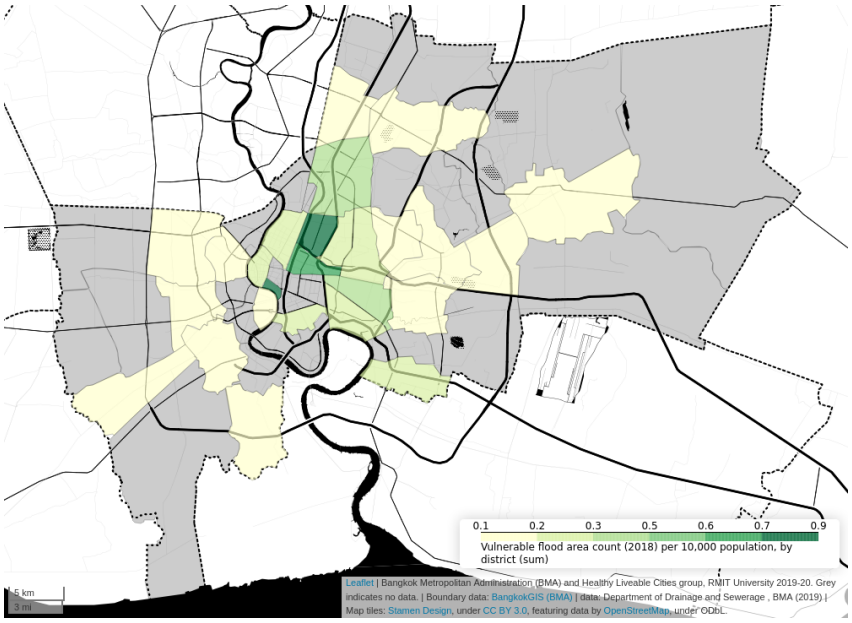


Fig. 87: Vulnerable flood area count (2018) per 10,000 population, by district

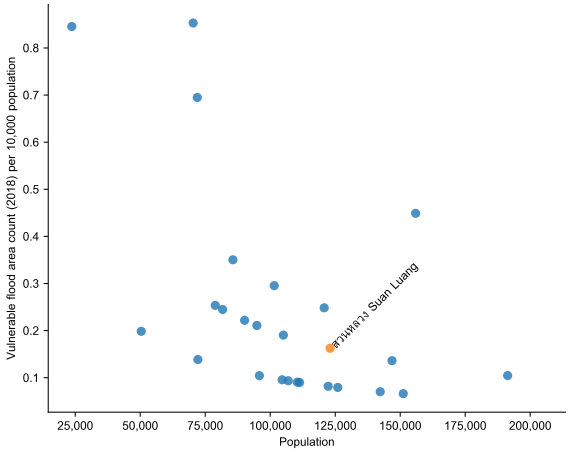


Fig. 88: Scatterplot of flood risk locations by population for districts.

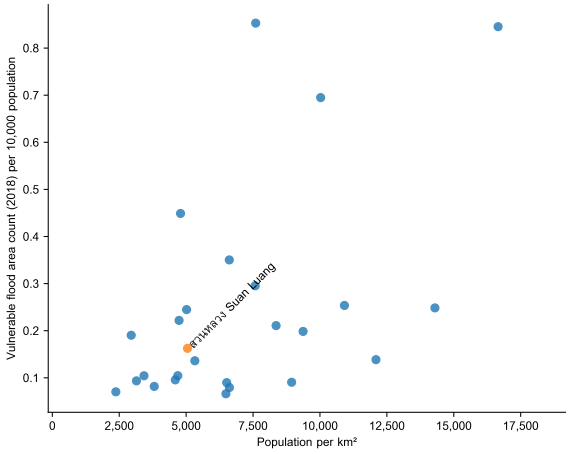


Fig. 89: Scatterplot of flood risk locations by population density for districts.

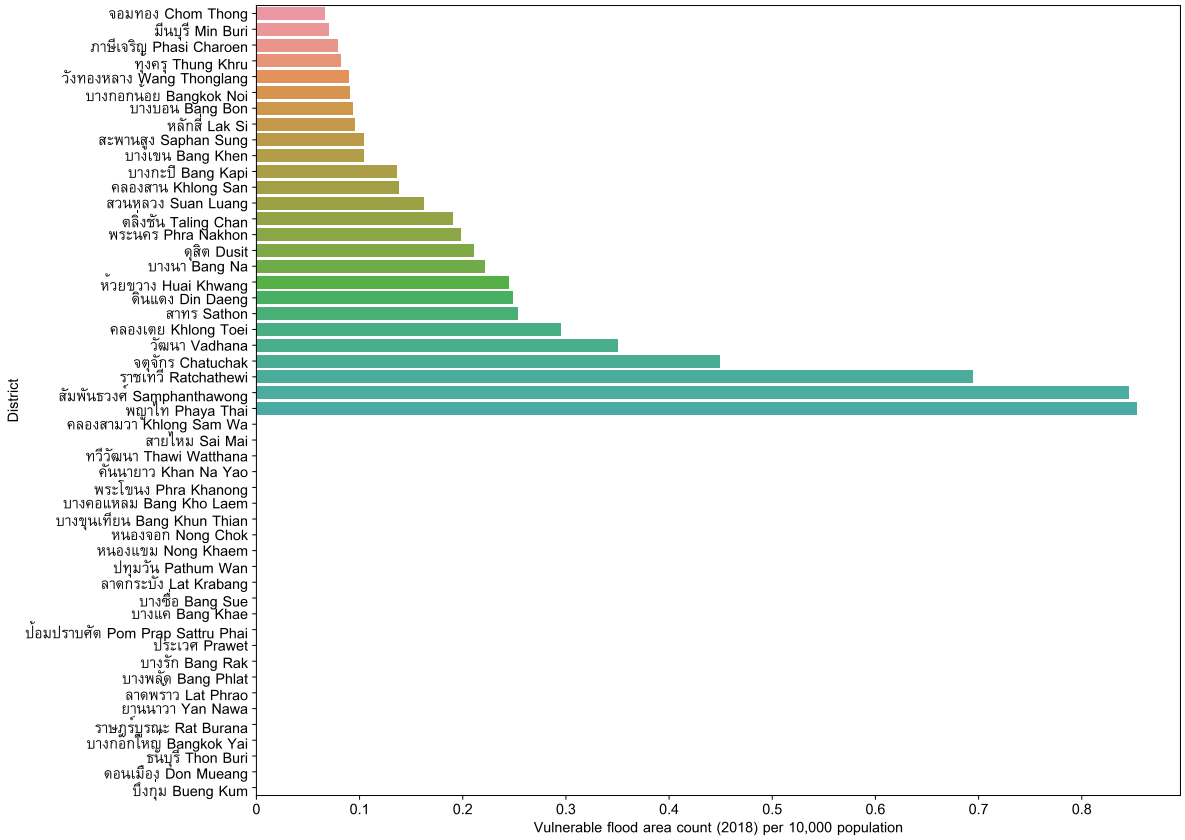


Fig. 90: Districts ranked in ascending order by flood risk locations with regard to vulnerable flood area count (2018) per 10,000 population.

Vulnerable flood area count (2018) per 10,000 household

The count of vulnerable flood areas associated with each analysis area was recorded. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 11, 13.

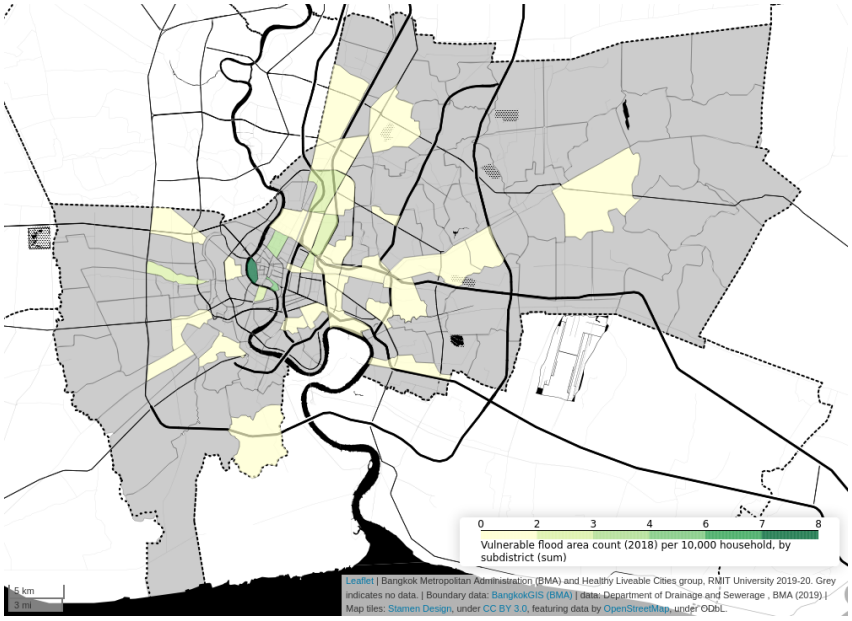


Fig. 91: Vulnerable flood area count (2018) per 10,000 household, by subdistrict

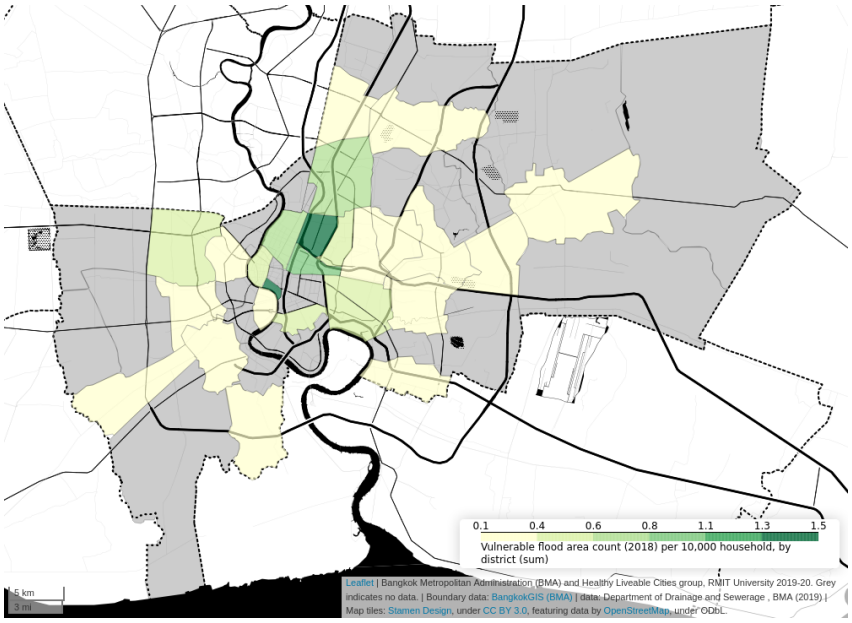


Fig. 92: Vulnerable flood area count (2018) per 10,000 household, by district

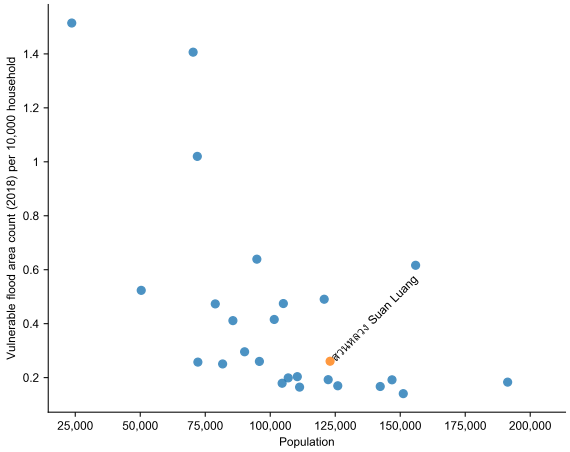


Fig. 93: Scatterplot of flood risk locations by population for districts.

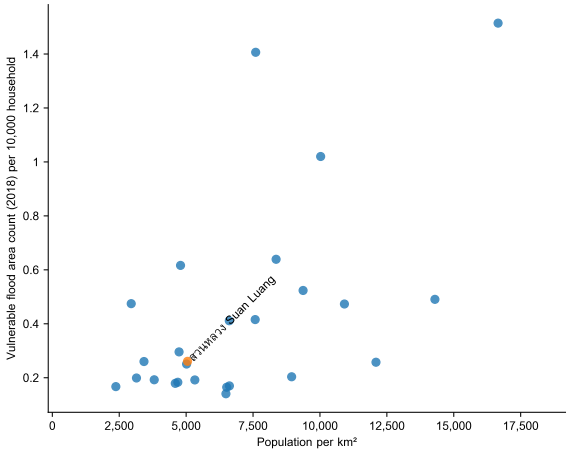


Fig. 94: Scatterplot of flood risk locations by population density for districts.

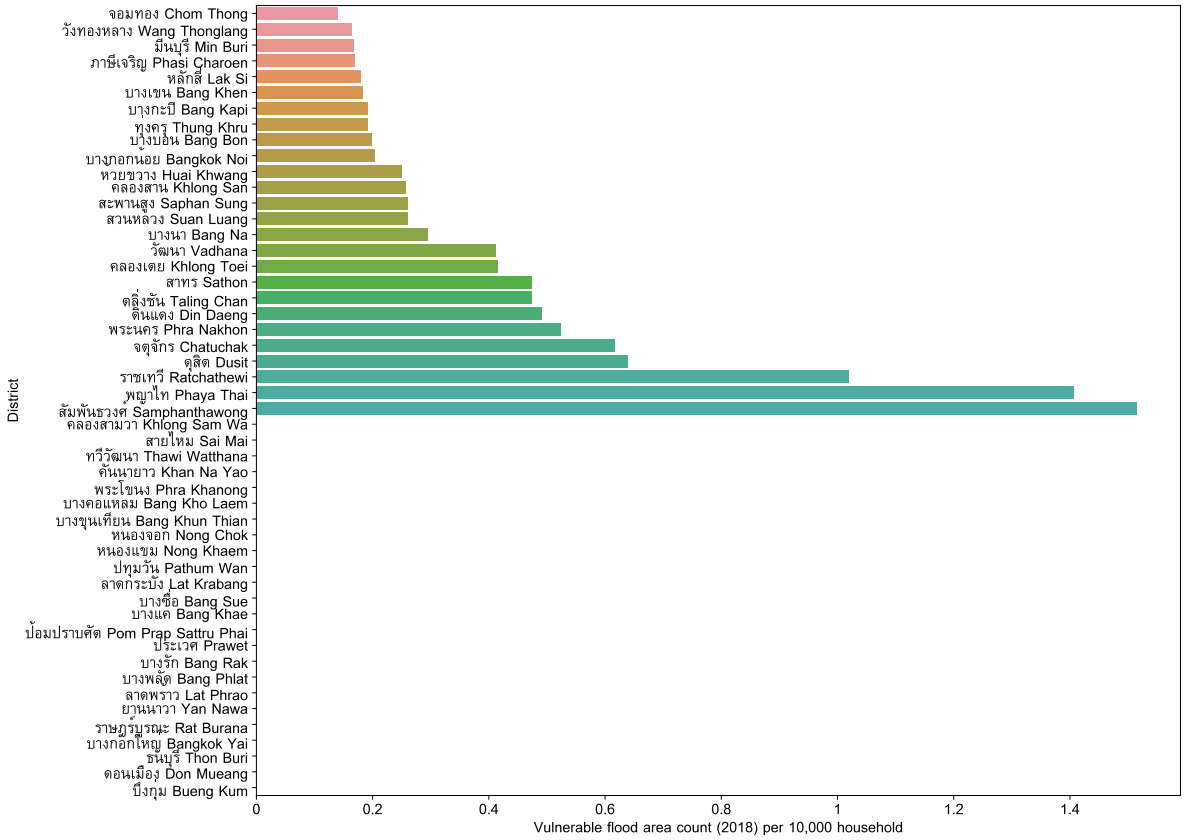


Fig. 95: Districts ranked in ascending order by flood risk locations with regard to vulnerable flood area count (2018) per 10,000 household.

2.3.5 High quality air

อากาศคุณภาพสูง

Air quality refers to the weather conditions within the area around us. High air quality is at a level that is clean, clear and free from pollution such as smoke, dust, gas etc. Human health, plants, animals and natural resources are threatened when air pollution reaches a high concentration. Poor air quality affects or is harmful to human health and / or the environment.

Dataset: Air quality: PM2.5

Data from monitoring stations were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with IDs for districts containing the monitoring stations. Point locations for monitoring stations were acquired from monitoring station geojson data retrieved from http://air4thai.pcd.go.th and aligned with the supplied data.

Data source: `From article (Thara Bua Kham Si. 2019. How many days does Bangkok people live in polluted air, toxic PM2.5 dust? Greenpeace. January 2019. https://www.greenpeace.org/thailand/story/2122/people-living-with-air-pollution/ accessed 6 July 2019) citing data sourced from Thai Pollution Control Department websites http://air4thai.pcd.go.th and http://aqmthai.com/public_report.php`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190809`

Licence: none specified

Date type: integer

Scale / Resolution: area summary

Citation: Thara Bua Kham Si. 2019. How many days does Bangkok people live in polluted air, toxic PM2.5 dust? Greenpeace. January 2019. https://www.greenpeace.org/thailand/story/2122/people-living-with-air-pollution/ accessed 6 July 2019

Notes: From article (Thara Bua Kham Si. 2019. How many days does Bangkok people live in polluted air, toxic PM2.5 dust? Greenpeace. January 2019. https://www.greenpeace.org/thailand/story/2122/people-living-with-air-pollution/ accessed 6 July 2019) citing data sourced from Thai Pollution Control Department websites http://air4thai.pcd.go.th and http://aqmthai.com/public_report.php

Data location relative to project folder: ./data/Thai/_from BMA/20190809/transfer_1673010_files_4a5fe795/air quality in Bangkok 2019 kn 7719.xlsx

Air quality monitoring stations (2019)

The count of monitoring stations in each analysis area was recorded.

Aligns with Sustainable Development Goals: 3, 7, 11, 2, 13.

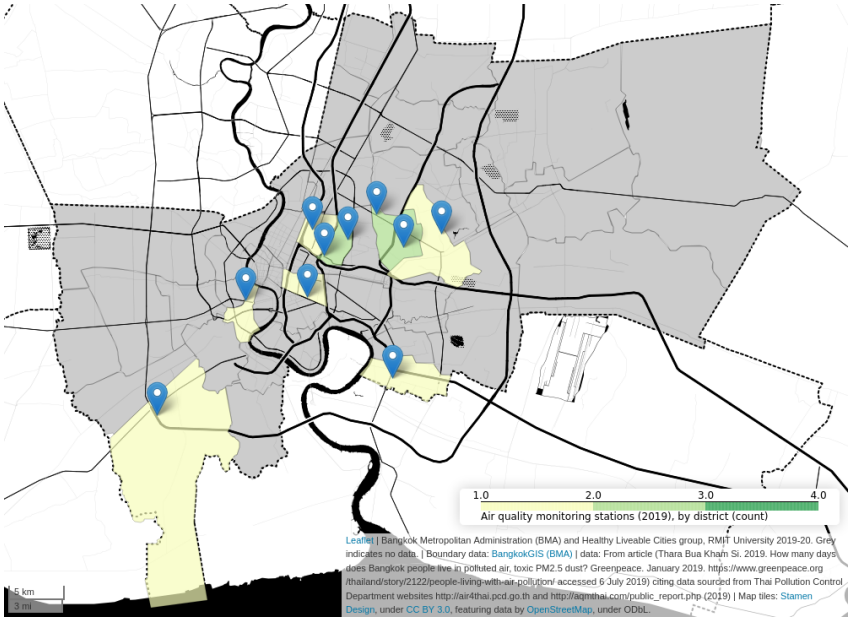


Fig. 96: Air quality monitoring stations (2019), by district

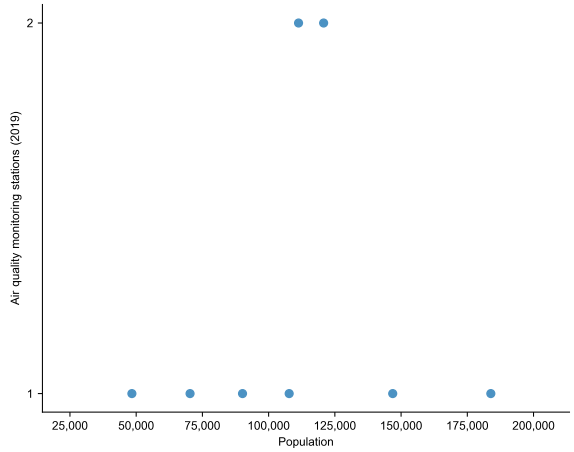


Fig. 97: Scatterplot of stationID by population for districts.

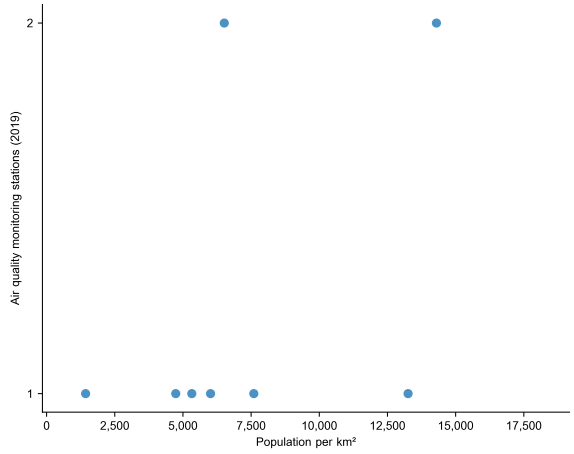


Fig. 98: Scatterplot of stationID by population density for districts.

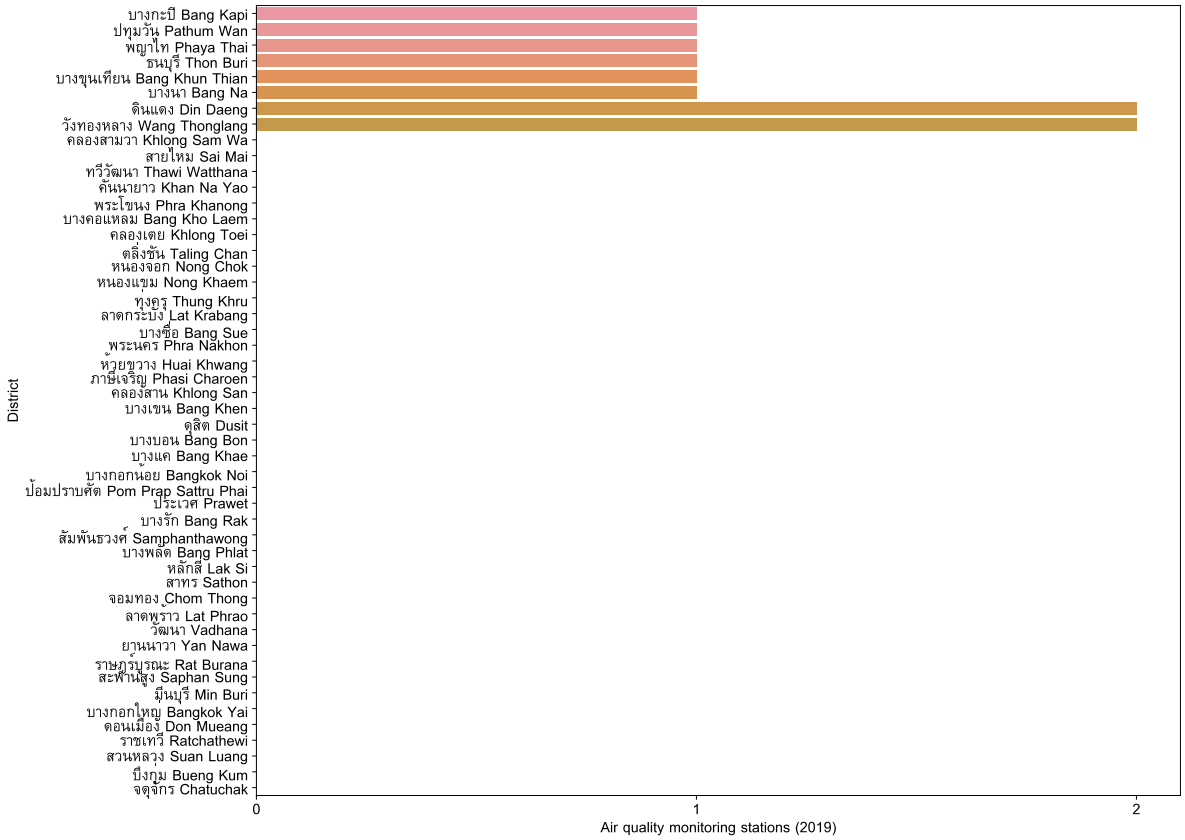


Fig. 99: Districts ranked in ascending order by stationid with regard to air quality monitoring stations (2019).

Air quality monitoring stations (2019) per km²

The count of monitoring stations in each analysis area was recorded. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 3, 7, 11, 2, 13.

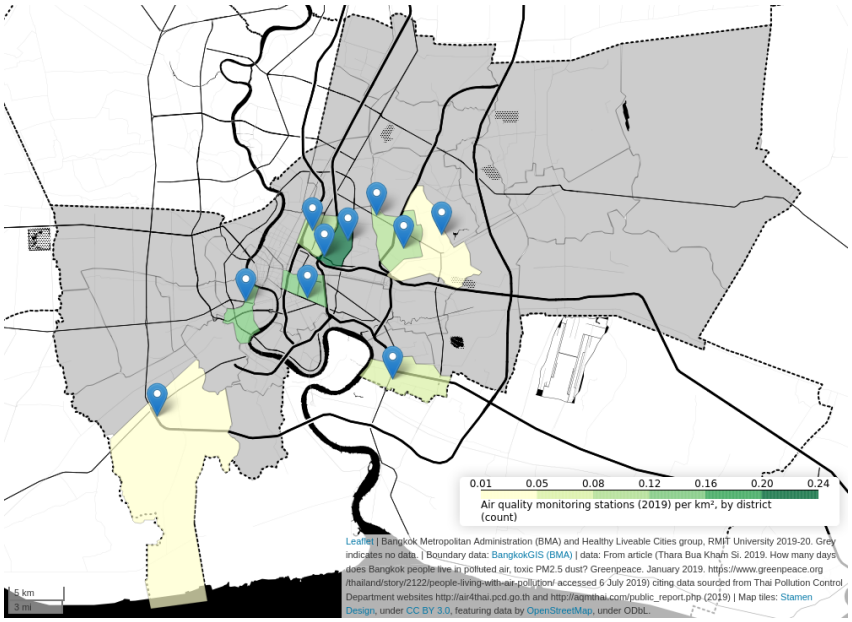


Fig. 100: Air quality monitoring stations (2019) per km^2, by district

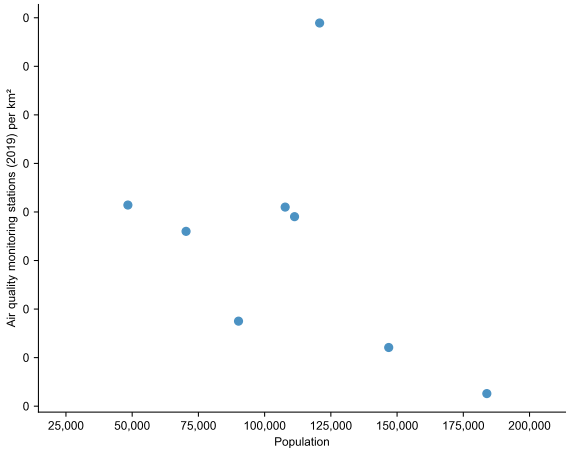


Fig. 101: Scatterplot of stationID by population for districts.

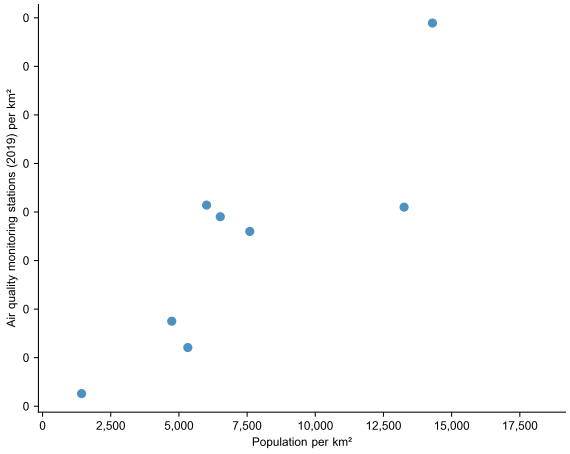


Fig. 102: Scatterplot of stationID by population density for districts.

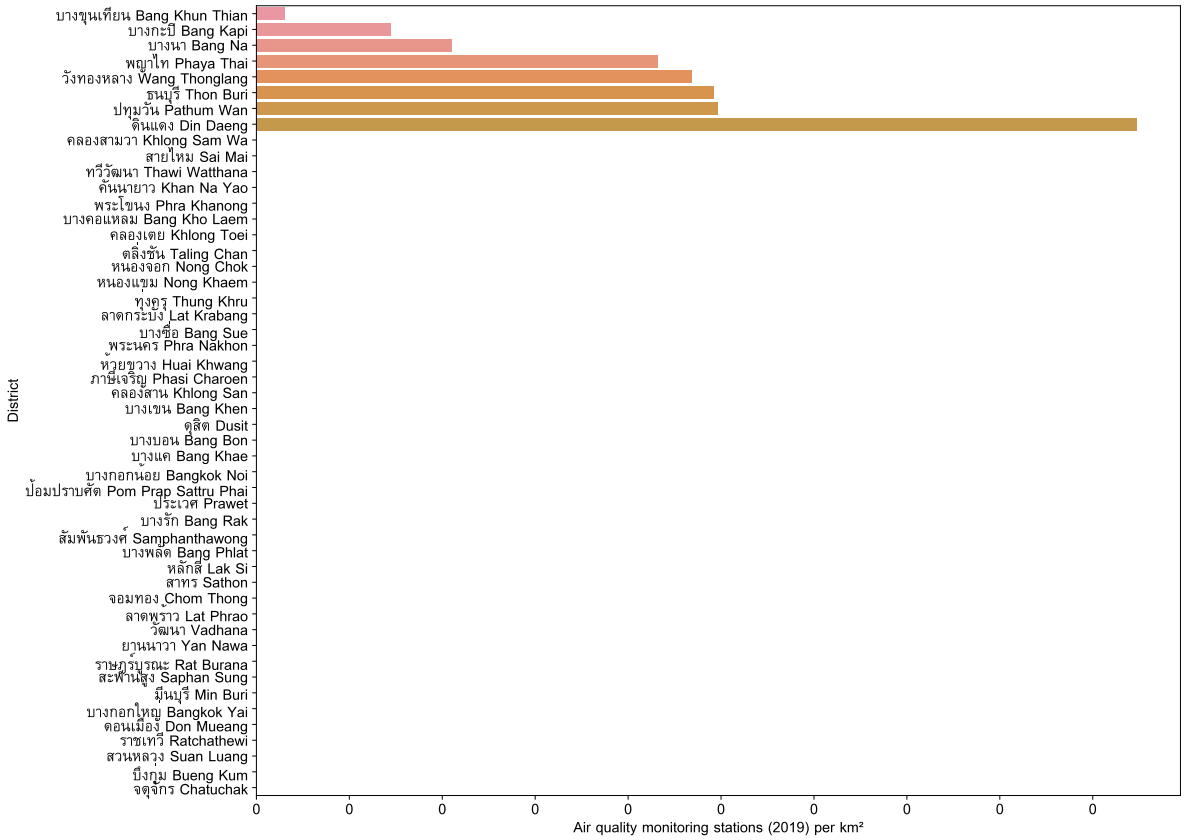


Fig. 103: Districts ranked in ascending order by stationid with regard to air quality monitoring stations (2019) per km^2.

Air quality monitoring stations (2019) per 10,000 population

The count of monitoring stations in each analysis area was recorded. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 3, 7, 11, 2, 13.

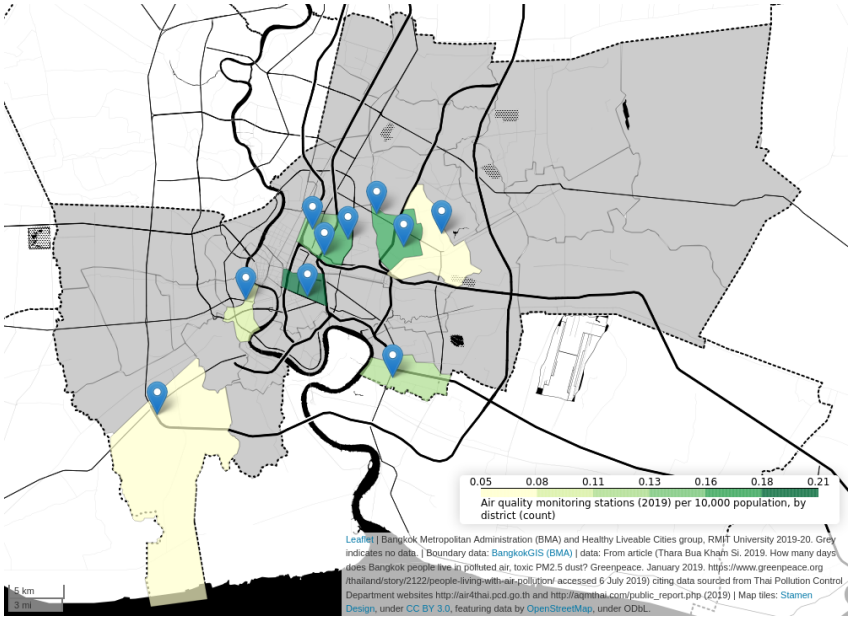


Fig. 104: Air quality monitoring stations (2019) per 10,000 population, by district

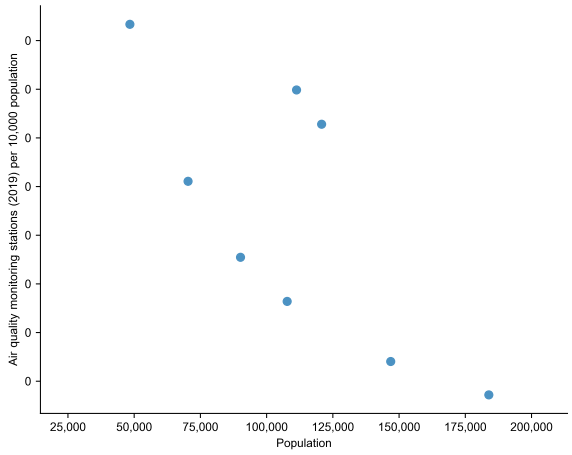


Fig. 105: Scatterplot of stationID by population for districts.

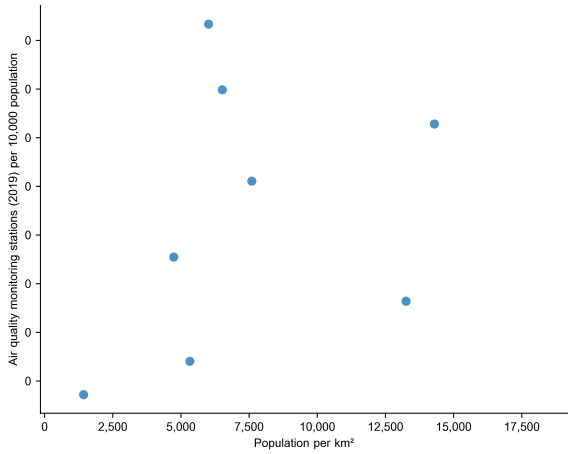


Fig. 106: Scatterplot of stationID by population density for districts.

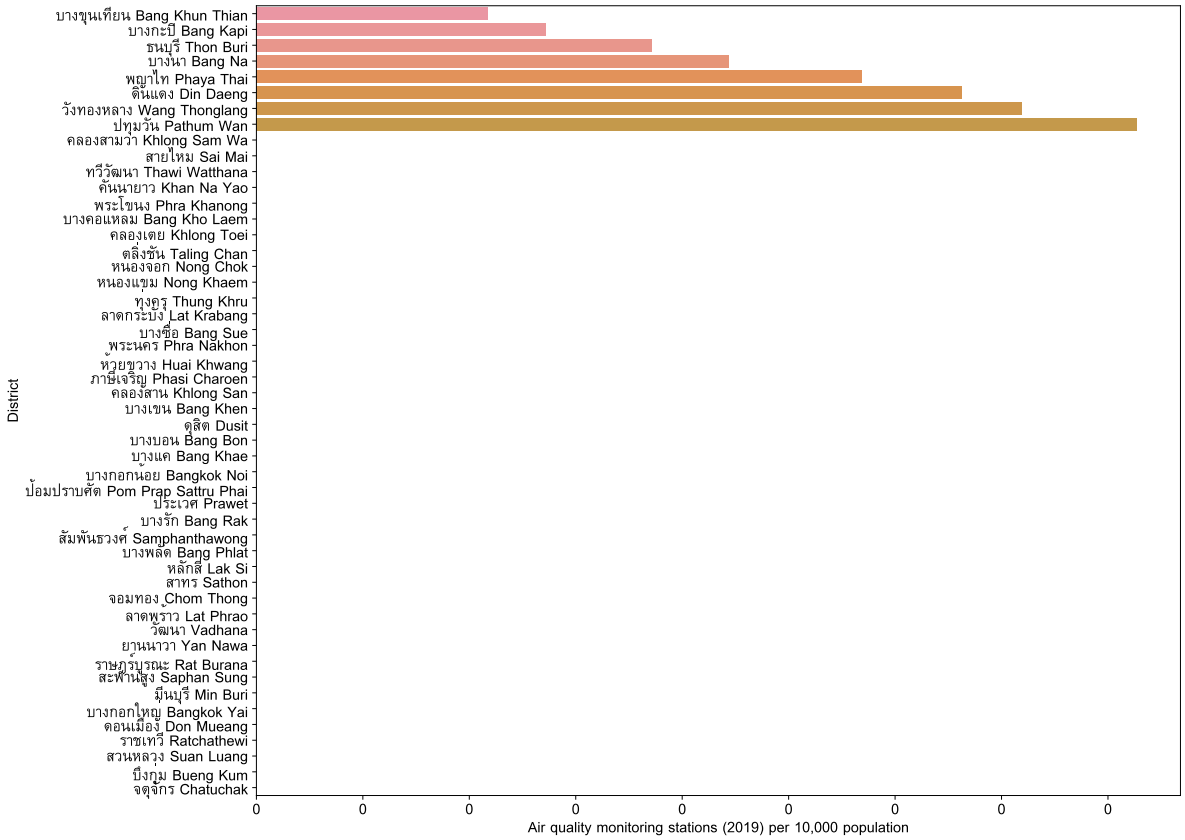


Fig. 107: Districts ranked in ascending order by stationid with regard to air quality monitoring stations (2019) per 10,000 population.

Air quality monitoring stations (2019) per 10,000 household

The count of monitoring stations in each analysis area was recorded. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 3, 7, 11, 2, 13.

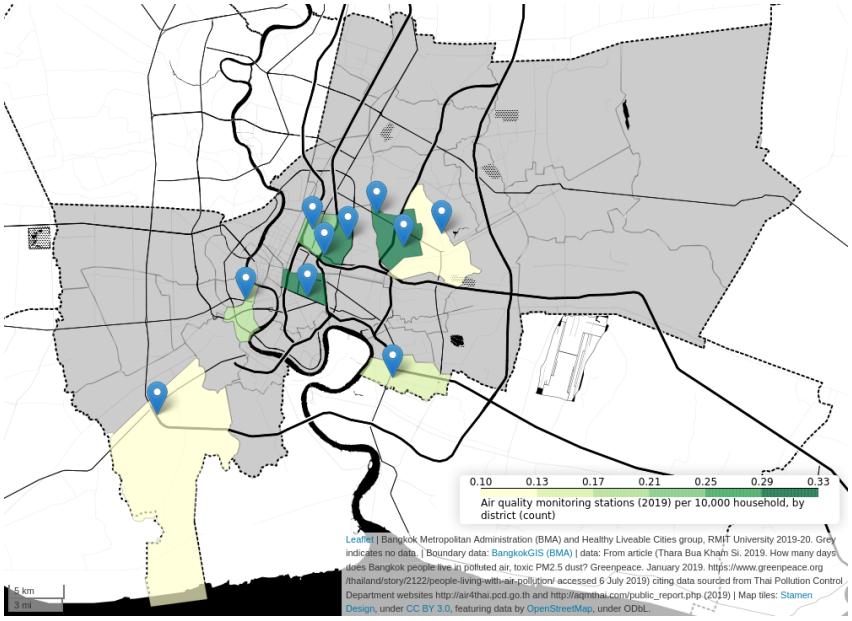


Fig. 108: Air quality monitoring stations (2019) per 10,000 household, by district

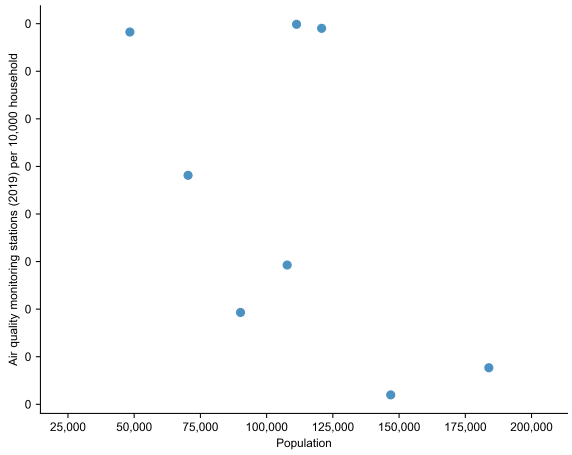


Fig. 109: Scatterplot of stationID by population for districts.

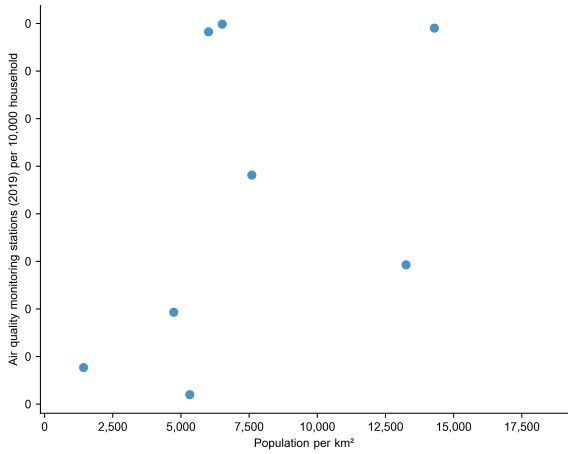


Fig. 110: Scatterplot of stationID by population density for districts.

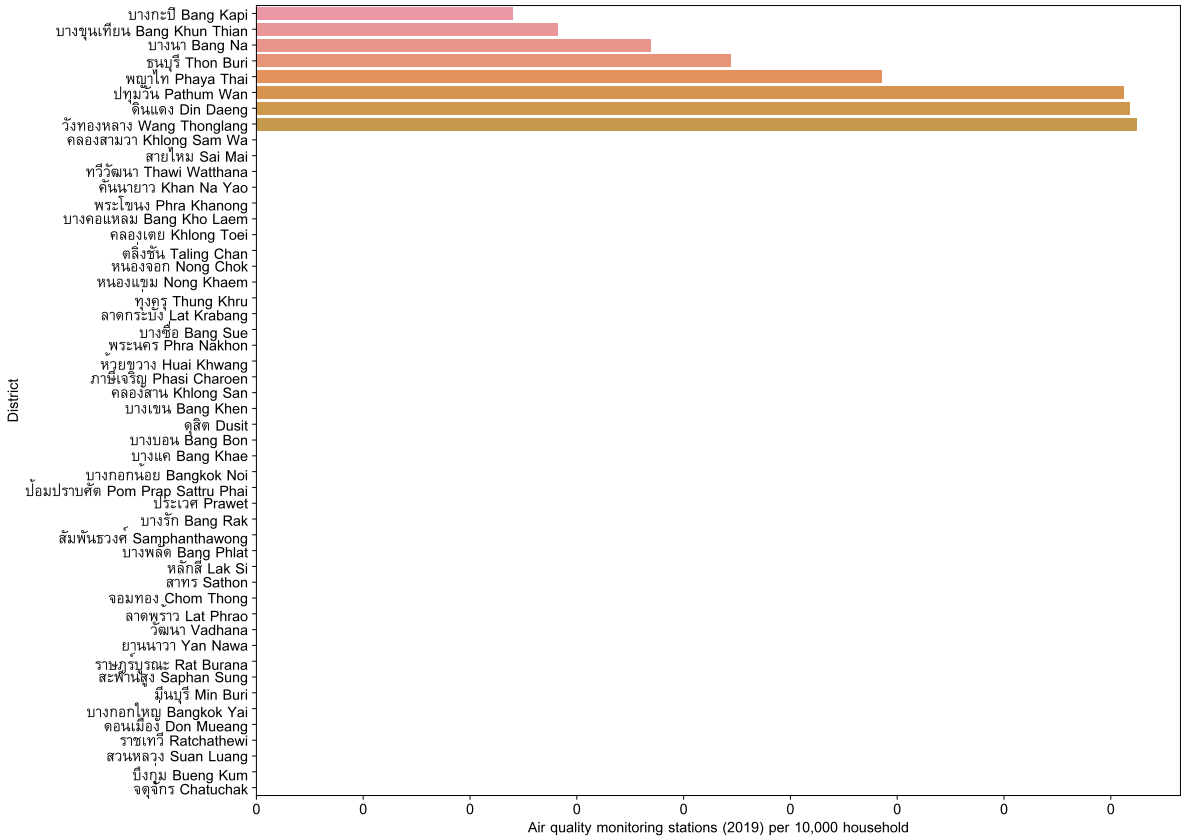


Fig. 111: Districts ranked in ascending order by stationid with regard to air quality monitoring stations (2019) per 10,000 household.

Number of days PM 2.5 exceeds Thai standard (50 µg/m^3; January 2019, PCD)

The average number of days PM 2.5 levels exceeded Thai standards during January 2019 were recorded for each analysis area, based on monitoring station records.

Aligns with Sustainable Development Goals: 3, 7, 11, 2, 13.

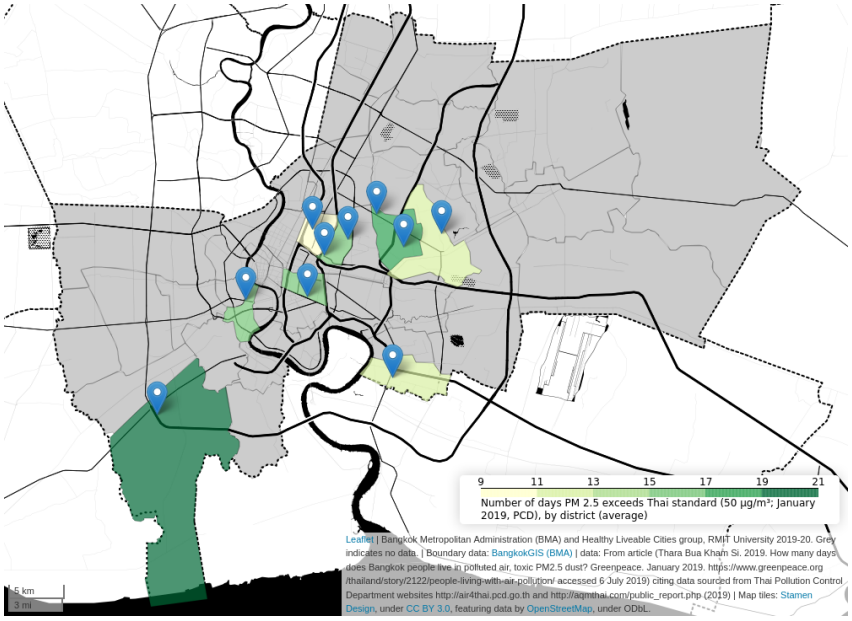


Fig. 112: Number of days PM 2.5 exceeds Thai standard (50 µg/m^3; January 2019, PCD), by district

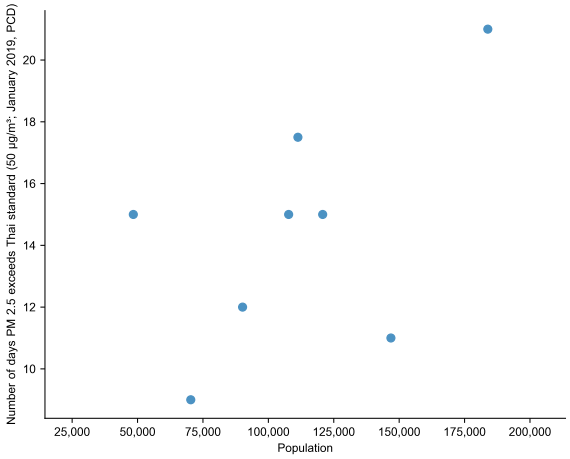


Fig. 113: Scatterplot of days exceeding Thai standard (50 µg/m^3; January 2019, PCD) by population for districts.

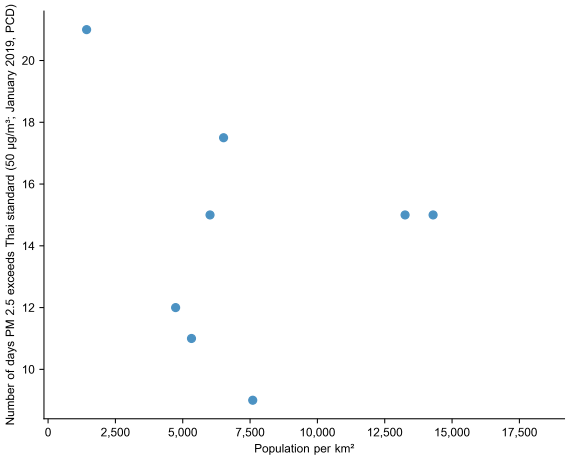


Fig. 114: Scatterplot of days exceeding Thai standard (50 µg/m^3; January 2019, PCD) by population density for districts.

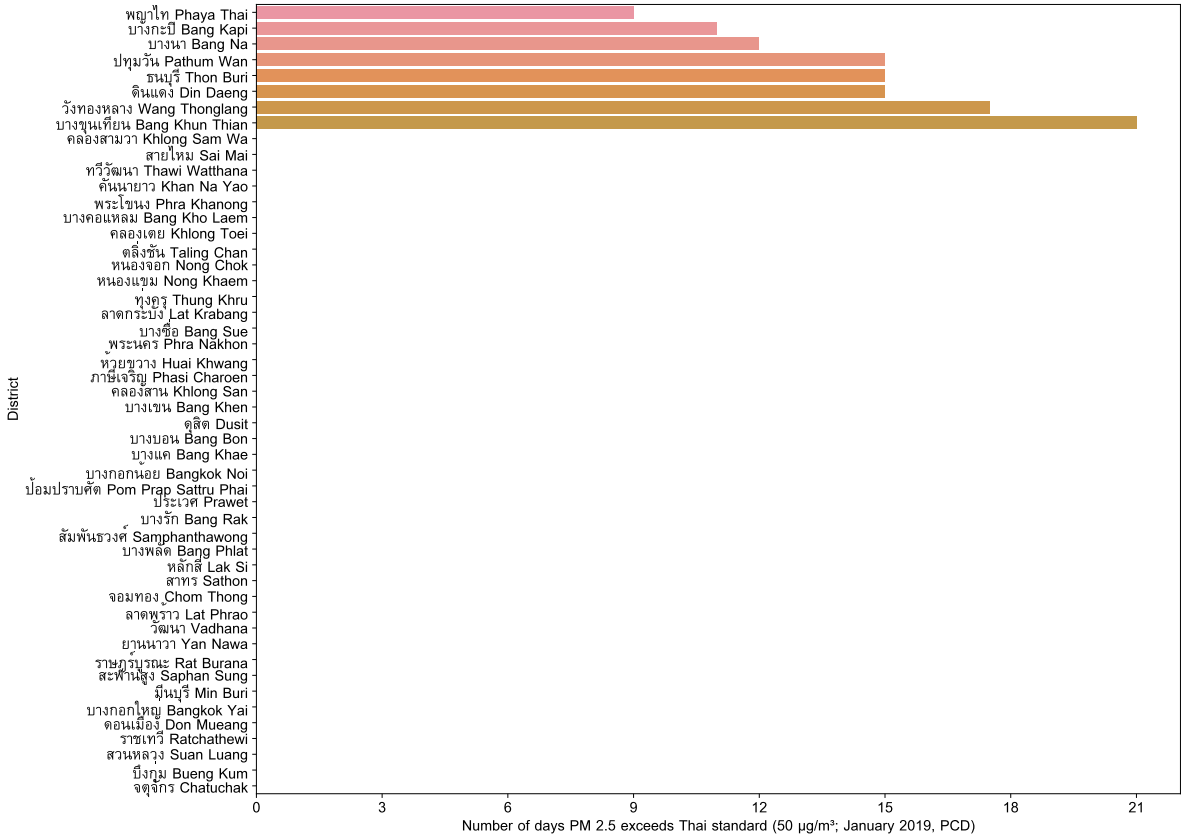


Fig. 115: Districts ranked in ascending order by days exceeding thai standard (50 µg/m^3; january 2019, pcd) with regard to number of days pm 2.5 exceeds thai standard (50 µg/m^3; january 2019, pcd).

Number of days PM 2.5 exceeds WHO standard (25 µg/m^3; January 2019, PCD)

The average number of days PM 2.5 levels exceeded WHO standards during January 2019 were recorded for each analysis area, based on monitoring station records.

Aligns with Sustainable Development Goals: 3, 7, 11, 2, 13.

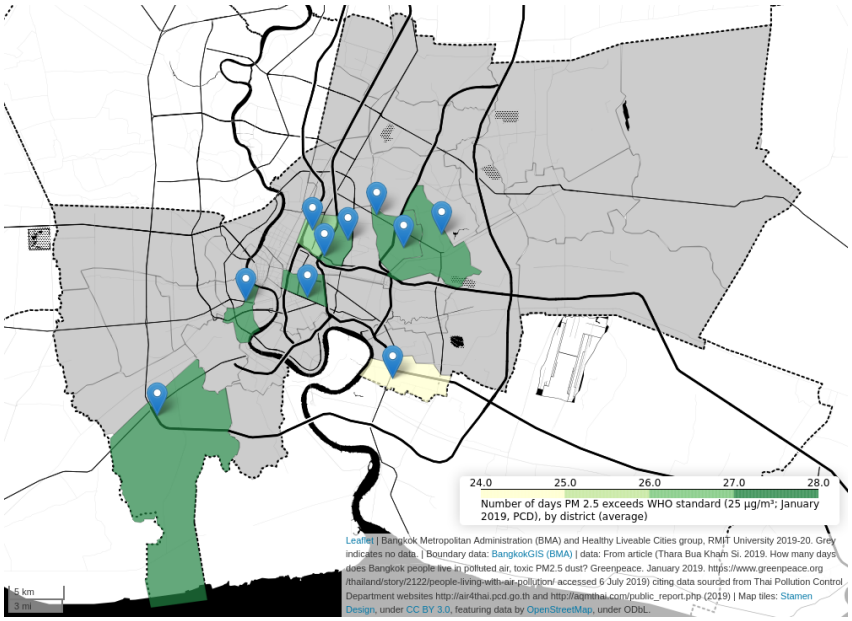


Fig. 116: Number of days PM 2.5 exceeds WHO standard (25 µg/m^3; January 2019, PCD), by district

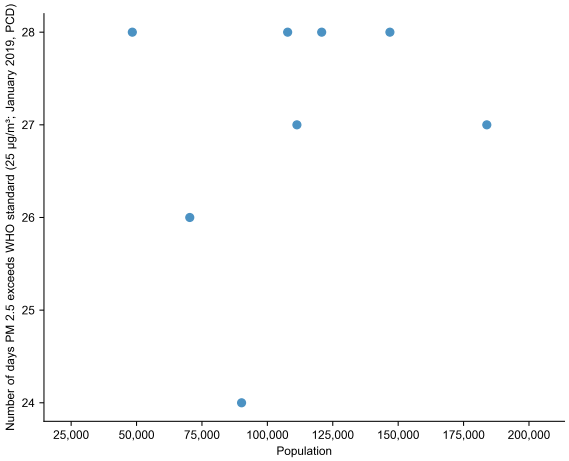


Fig. 117: Scatterplot of days exceeding WHO standard (25 µg/m^3; January 2019, PCD) by population for districts.

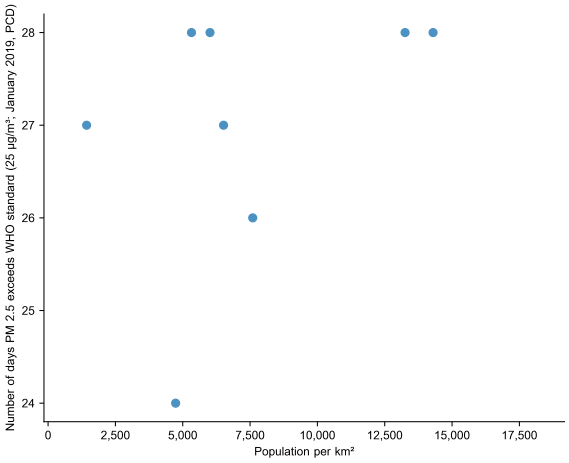


Fig. 118: Scatterplot of days exceeding WHO standard (25 µg/m^3; January 2019, PCD) by population density for districts.

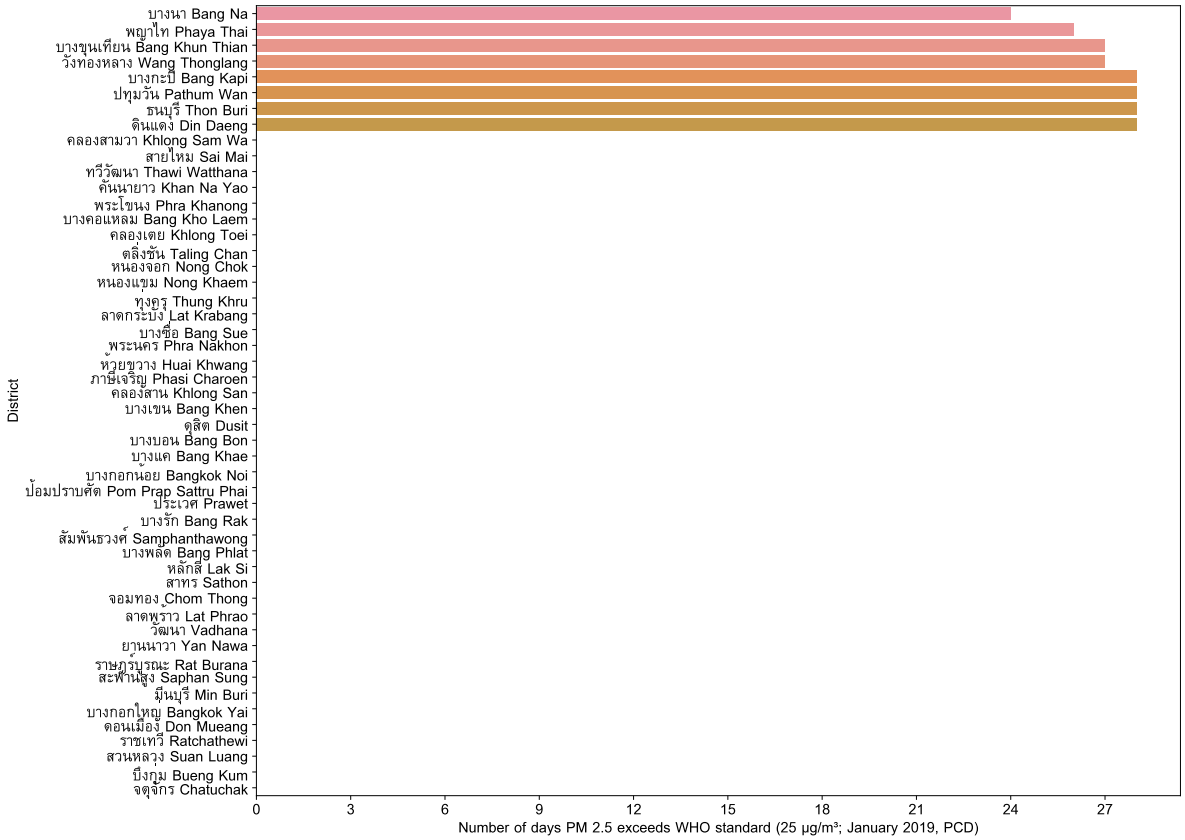


Fig. 119: Districts ranked in ascending order by days exceeding who standard (25 µg/m^3; january 2019, pcd) with regard to number of days pm 2.5 exceeds who standard (25 µg/m^3; january 2019, pcd).

Dataset: Sentinel-5P NRTI NO2: Near Real-Time Nitrogen Dioxide

Google Earth Engine was used to process Sentinel 5p data from the Copernicus satellite detailing total vertical column of NO2 (ratio of the slant column density of NO2 and the total air mass factor), taking the annual average from 13 October 2017 (commencement of the S5P monitoring mission) to 12 October 2018.

Data source: `Copernicus Sentinel Data processed using Google Earth Engine`

URL: `https://developers.google.com/earth-engine/datasets/catalog/COPERNICUS_S5P_NRTI_L3_NO2`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20191009`

Licence: `Free, full and open access for lawful usage, with attribution`

Licence URL: `https://sentinel.esa.int/documents/247904/690755/Sentinel_Data_Legal_Notice`

Spatial reference (EPSG code): `4326.0`

Date type: `raster:float64`

Scale / Resolution: `10`

Notes: `Free access, but must acknowledge Copernicus Sentinel, year of data and if it has been modified. Requires processing, as data is in half hourly updates.`

Data location relative to project folder: `./data/International/Google EarthEngine/copernicus_s5p_nrti_l3_no2-mean_col_num_density_20171013_20181012.tif`

Annual average NO2 (1-e6 mmol/m^2; 2017-18)

The total vertical column of NO2 is a measure of air pollution, however it is based on tropospheric and stratospheric presence of NO2 and measured in mmol per square metre; in contrast, health guidelines for exposure are usually based on ground monitoring of NO2, recorded in parts per billion. As a spatially continuous measure, annual average NO2 is useful for indicating areas of relatively intense pollution and may be compared with ground based measures (ie. from monitoring stations) as well as longitudinally to monitor change over time. For mapping purposes, NO2 was scaled as 1-e6 mmol per square metre (ie. divided by 0.000001).

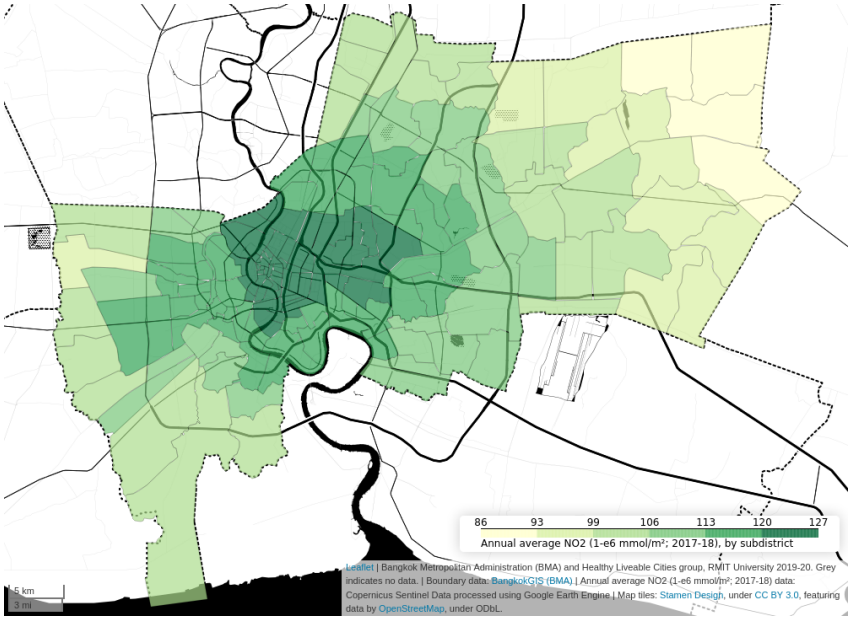


Fig. 120: Annual average NO2 (1-e6 mmol/m^2; 2017-18), by subdistrict

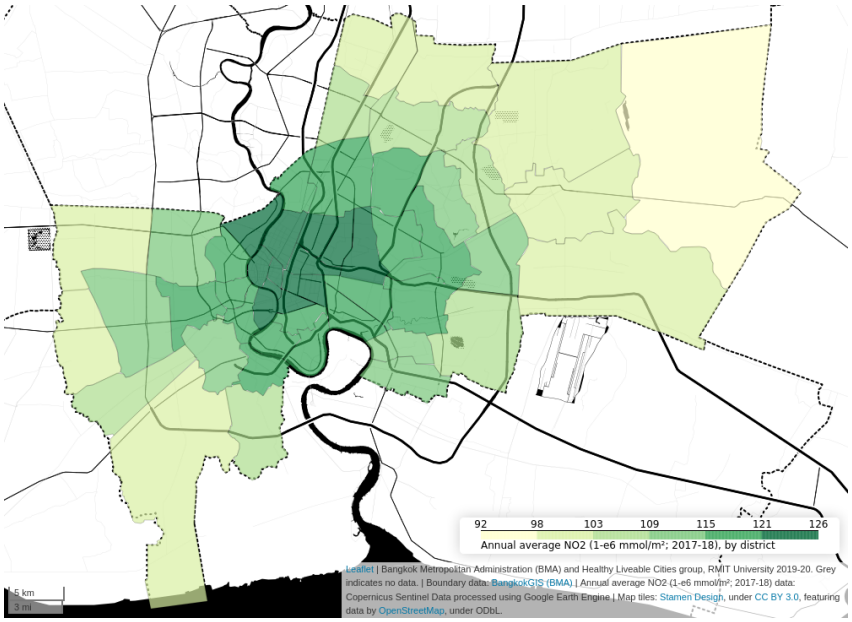


Fig. 121: Annual average NO2 (1-e6 mmol/m^2; 2017-18), by district

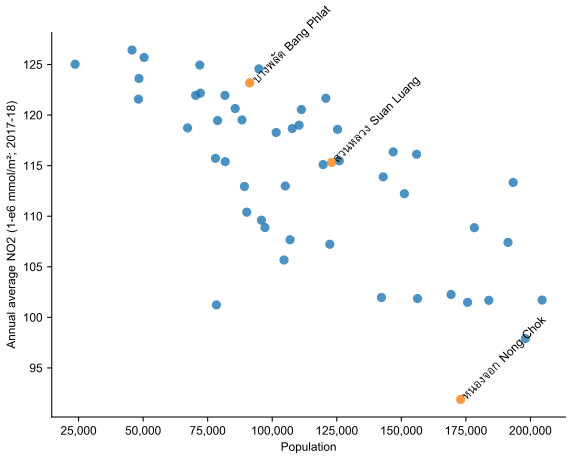


Fig. 122: Scatterplot of Annual average NO2 (1-e6 mmol/m^2; 2017-18) by population for districts.

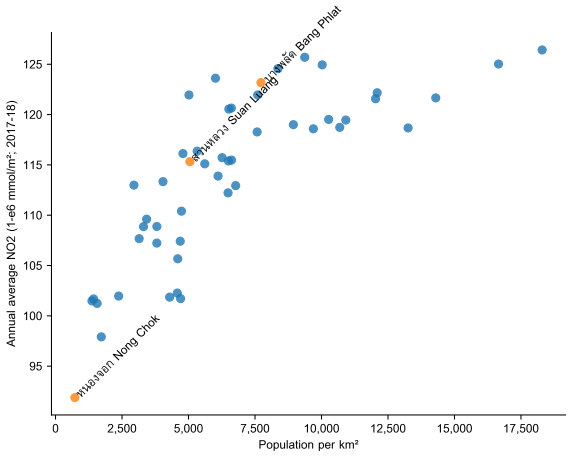


Fig. 123: Scatterplot of Annual average NO2 (1-e6 mmol/m^2; 2017-18) by population density for districts.

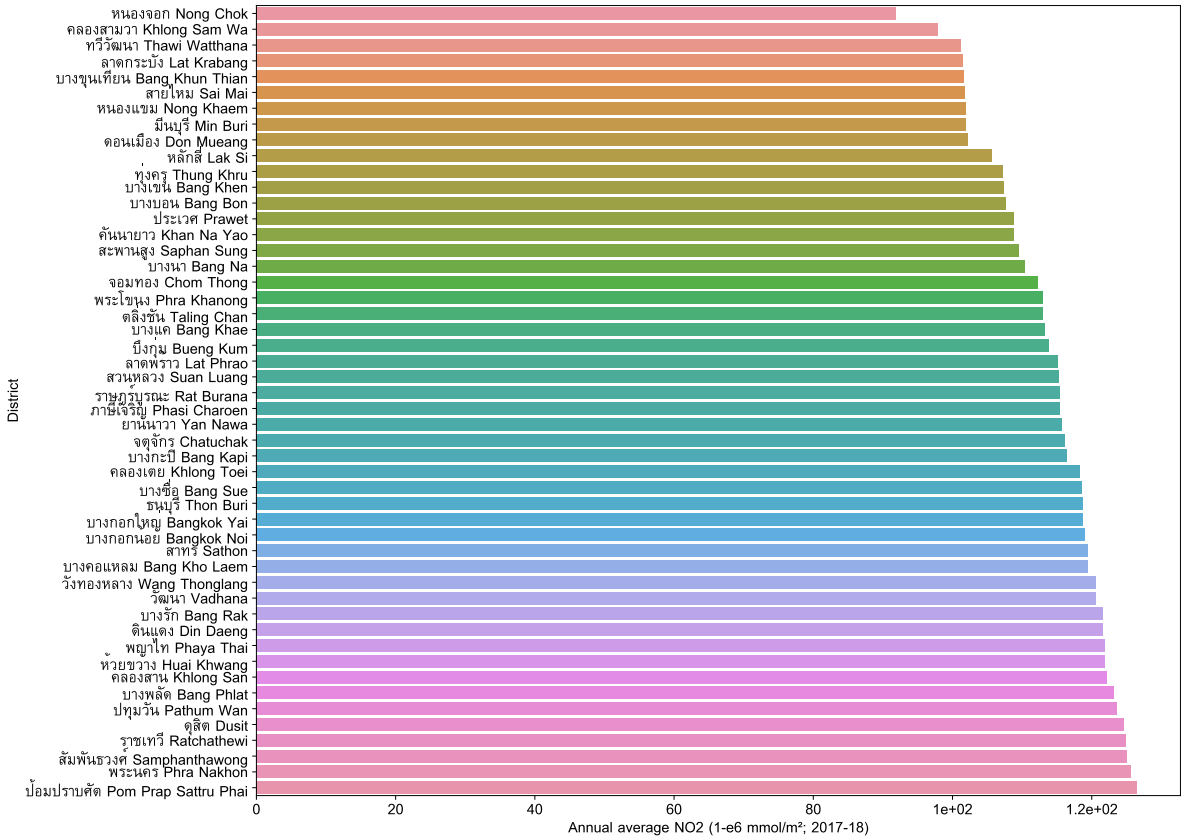


Fig. 124: Districts ranked in ascending order by annual average no2 (1-e6 mmol/m^2; 2017-18) with regard to annual average no2 (1-e6 mmol/m^2; 2017-18).

2.3.6 A safe environment

สิ่งแวดล้อมปลอดภัย

Environmental safety in an urban context refers to minimisation of risk of fire, crime and road accidents.

Dataset: Fire incidence

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with IDs.

Data source: `Fire and Rescue Department, BMA`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190809`

Licence: `none specified`

Date type: `table`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190809/transfer_1673010_files_4a5fe795/Fire Incidence in Bangkok 2018_kn8919.xlsx`

Fire incidence (2018)

The number of fire occurences recorded for each analysis area within 2018 was recorded.

Aligns with Sustainable Development Goals: 11, 13.

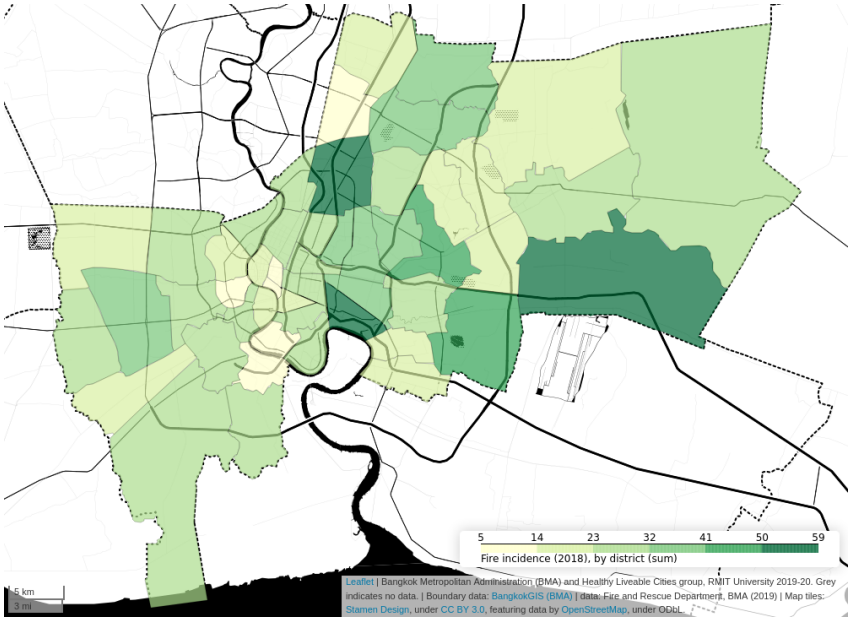


Fig. 125: Fire incidence (2018), by district

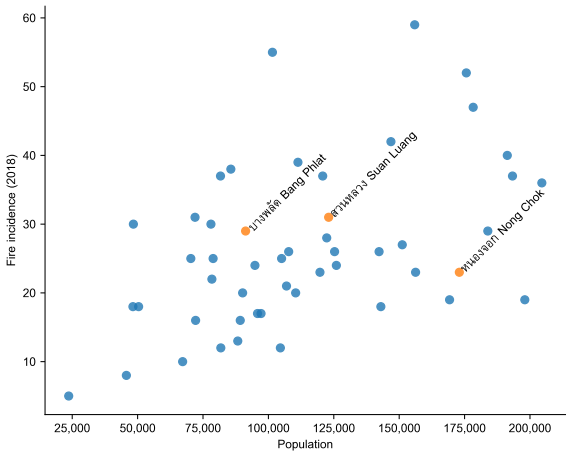


Fig. 126: Scatterplot of fire incidence by population for districts.

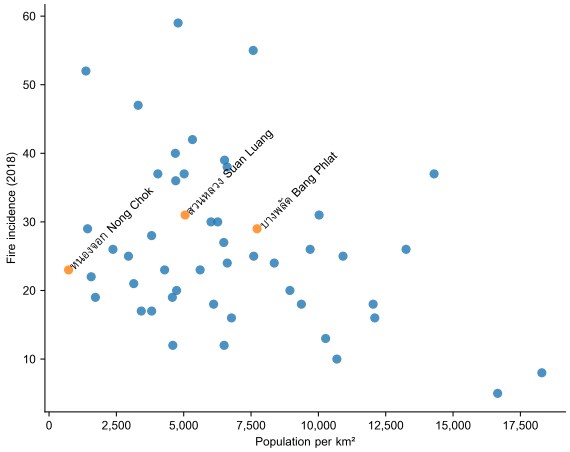


Fig. 127: Scatterplot of fire incidence by population density for districts.

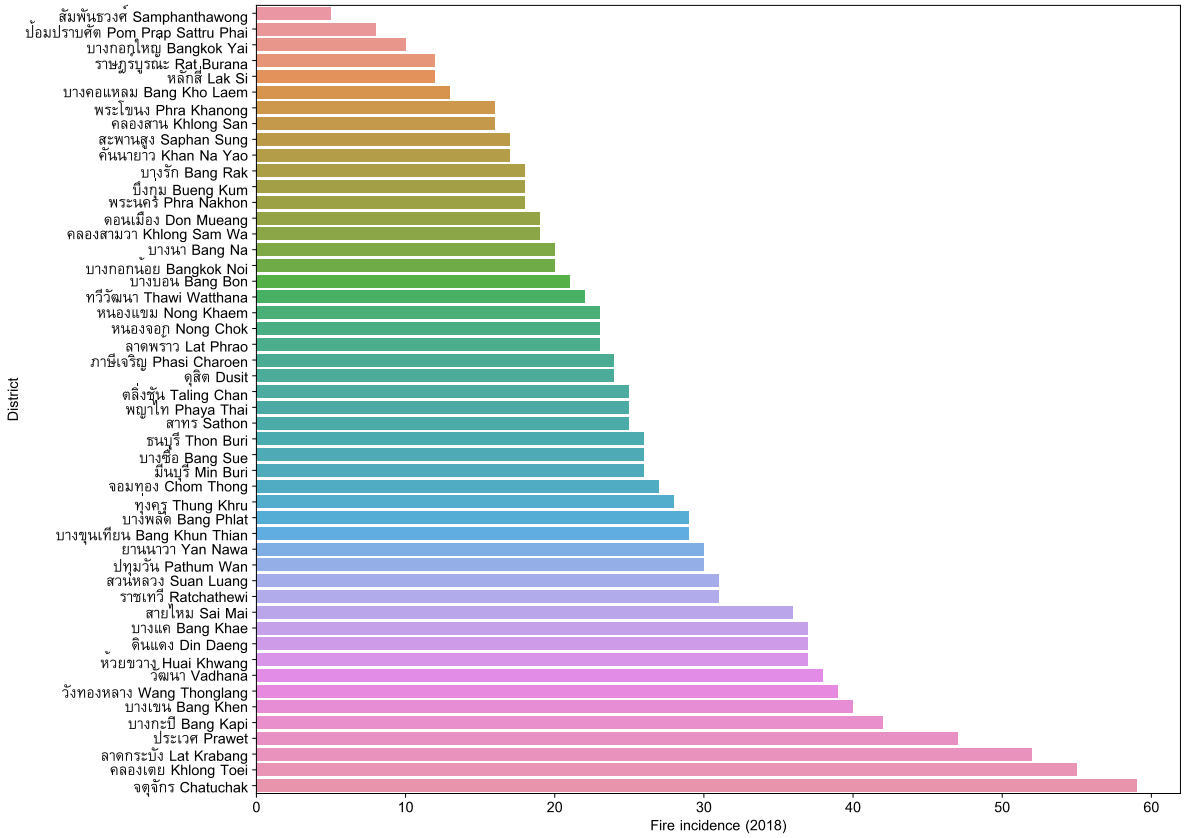


Fig. 128: Districts ranked in ascending order by fire incidence with regard to fire incidence (2018).

Fire incidence (2018) per km^2

The number of fire occurences recorded for each analysis area within 2018 was recorded. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 11, 13.

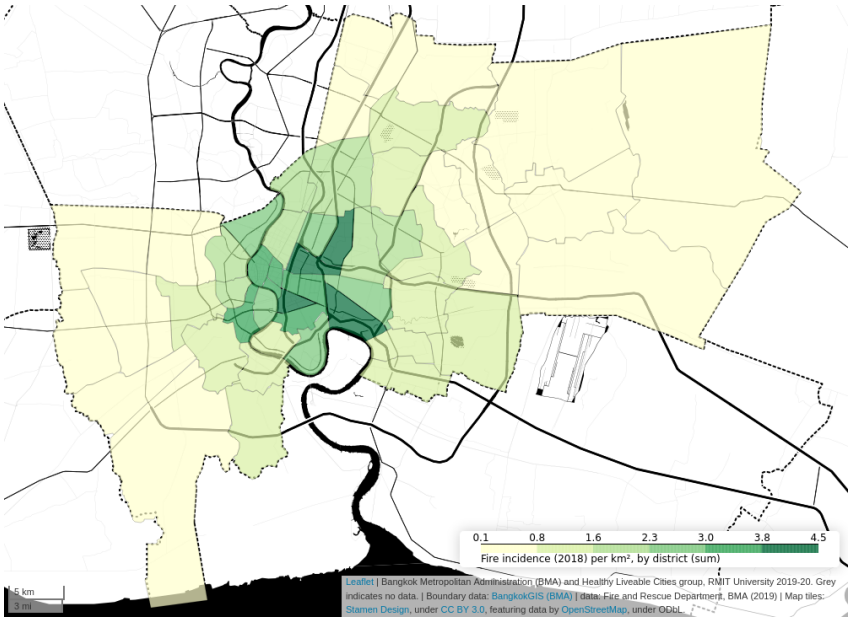


Fig. 129: Fire incidence (2018) per km^2, by district

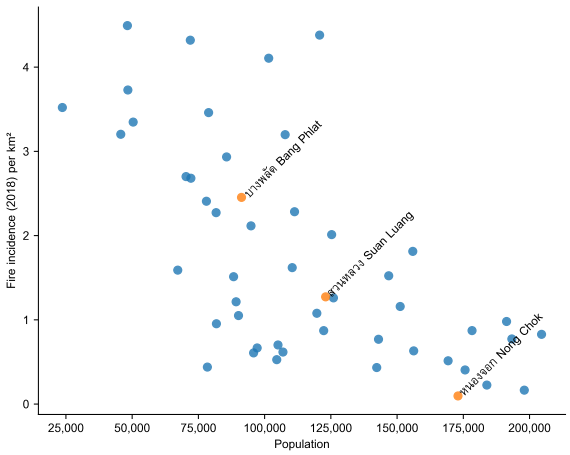


Fig. 130: Scatterplot of fire incidence by population for districts.

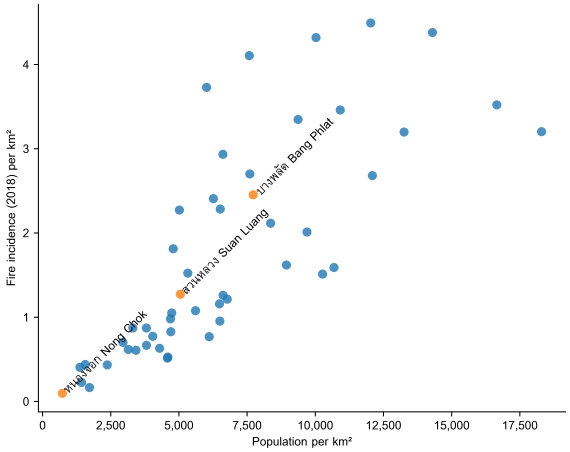


Fig. 131: Scatterplot of fire incidence by population density for districts.

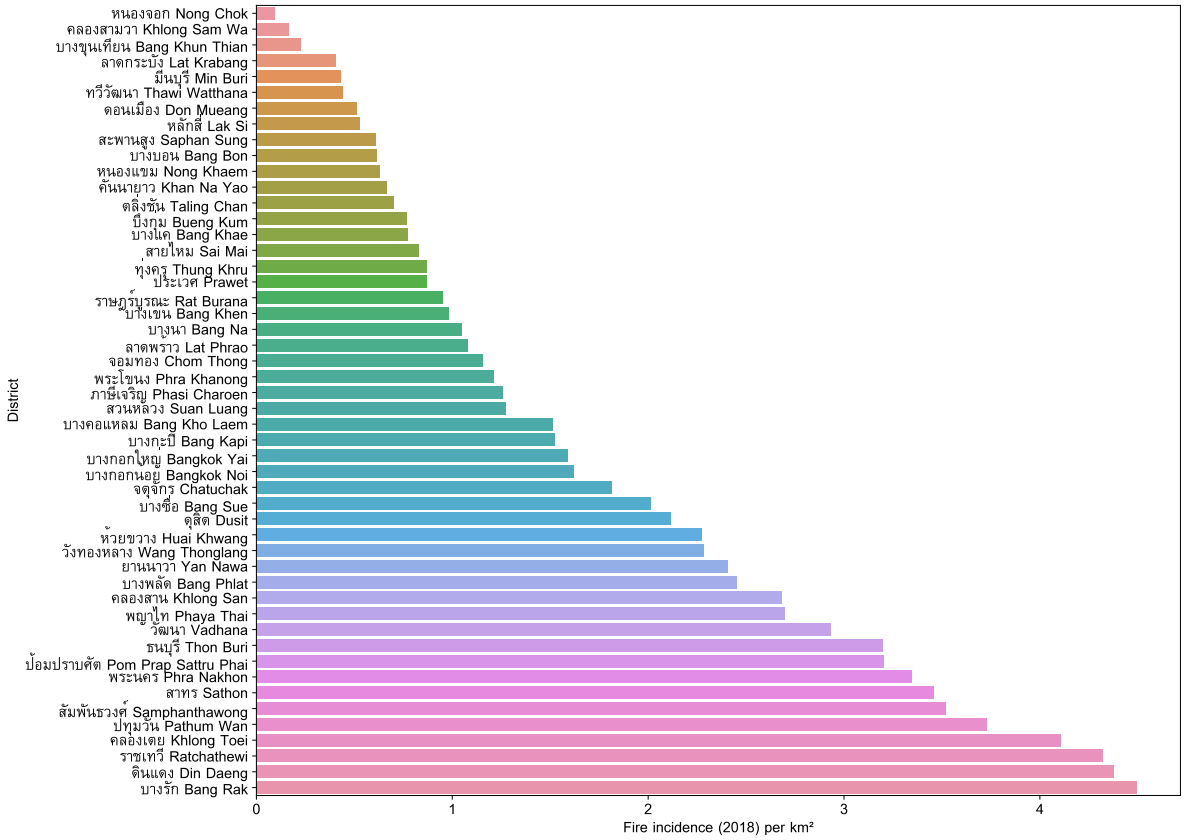


Fig. 132: Districts ranked in ascending order by fire incidence with regard to fire incidence (2018) per km^2.

Fire incidence (2018) per 10,000 population

The number of fire occurences recorded for each analysis area within 2018 was recorded. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 11, 13.

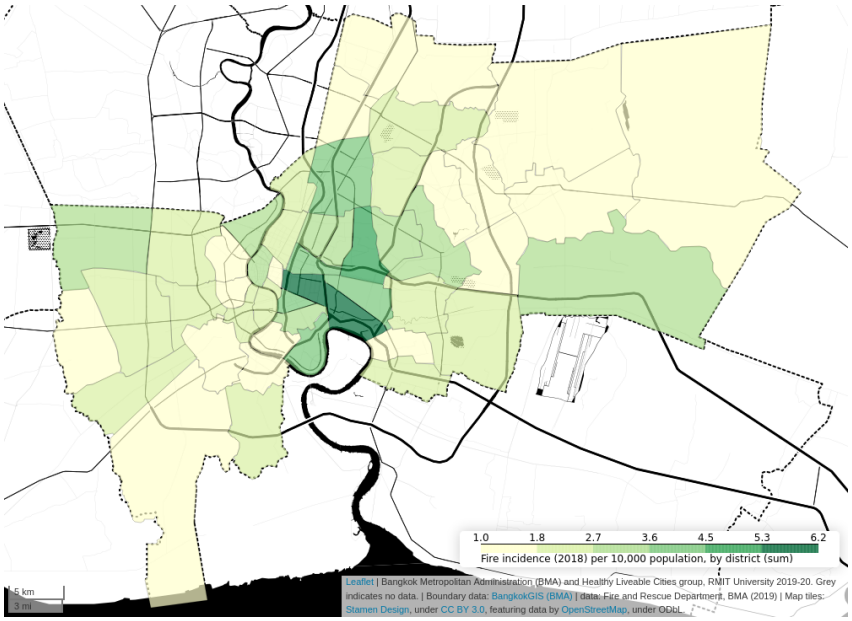


Fig. 133: Fire incidence (2018) per 10,000 population, by district

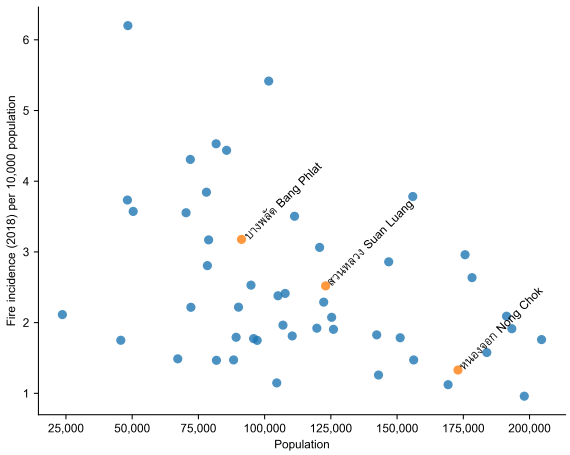


Fig. 134: Scatterplot of fire incidence by population for districts.

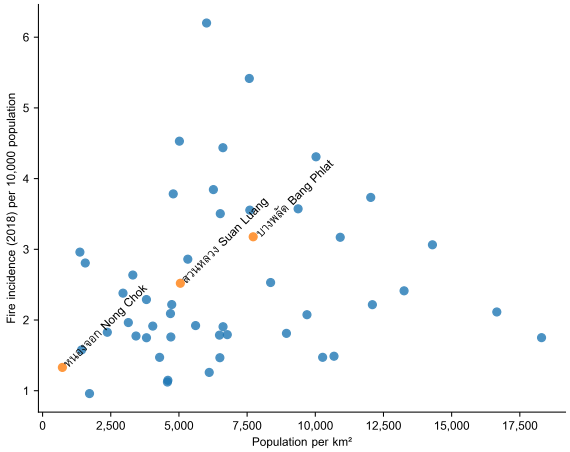


Fig. 135: Scatterplot of fire incidence by population density for districts.

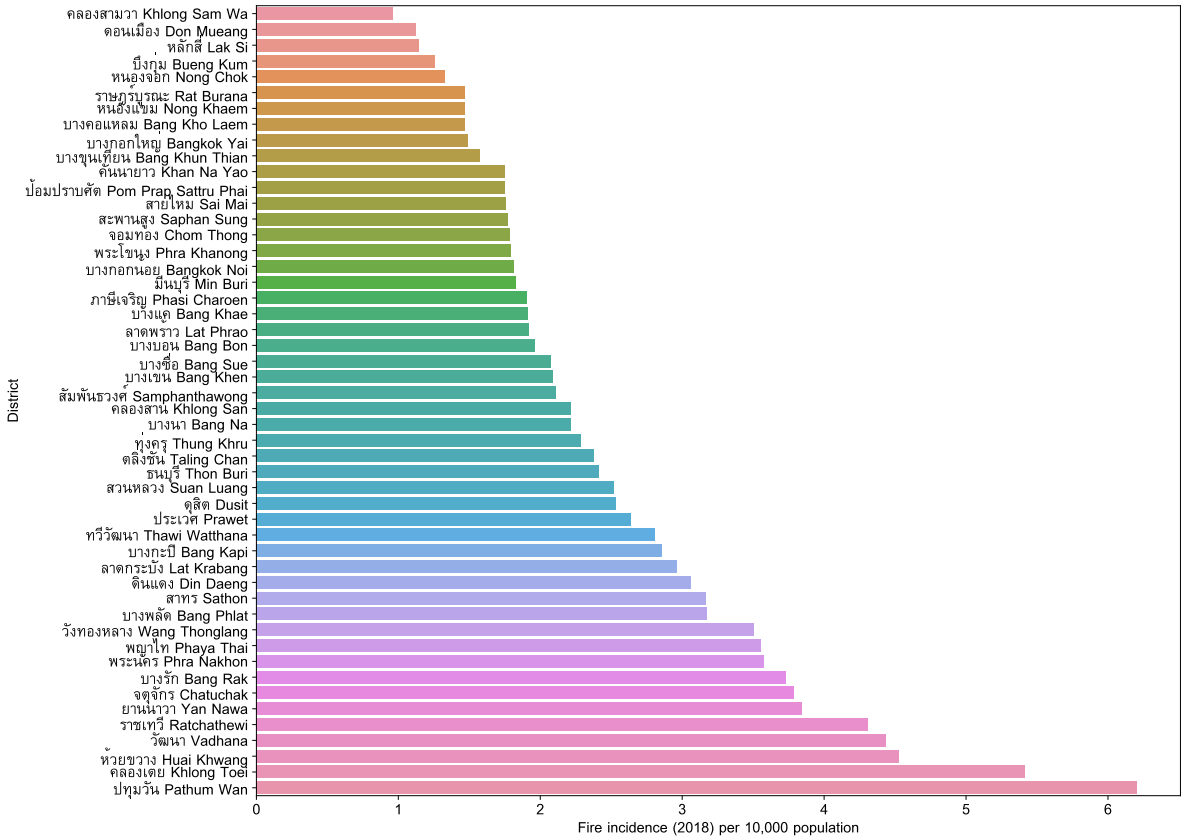


Fig. 136: Districts ranked in ascending order by fire incidence with regard to fire incidence (2018) per 10,000 population.

Fire incidence (2018) per 10,000 household

The number of fire occurences recorded for each analysis area within 2018 was recorded. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 11, 13.

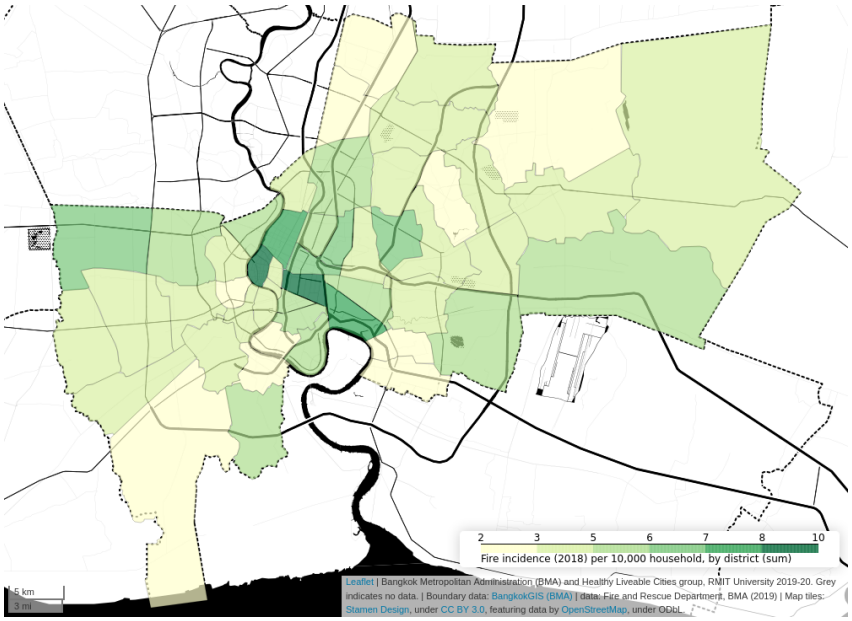


Fig. 137: Fire incidence (2018) per 10,000 household, by district

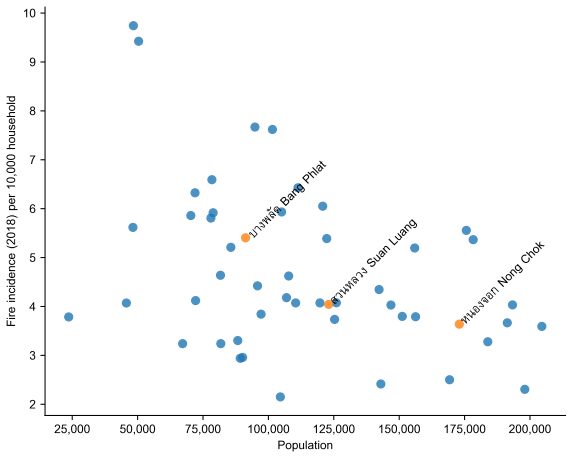


Fig. 138: Scatterplot of fire incidence by population for districts.

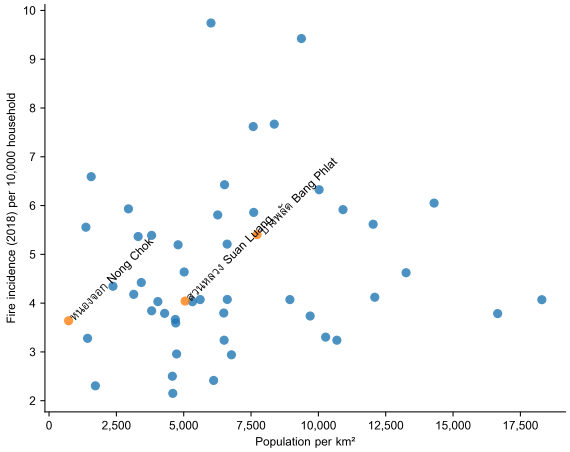


Fig. 139: Scatterplot of fire incidence by population density for districts.

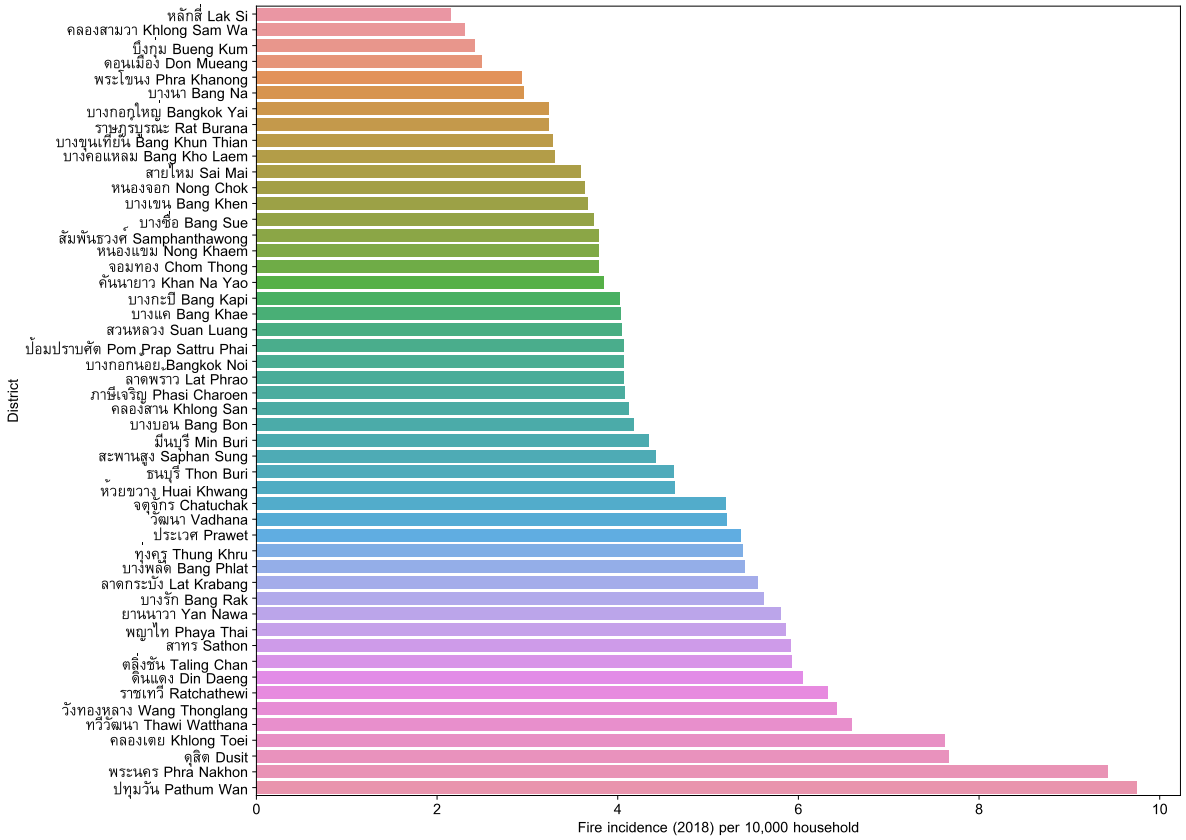


Fig. 140: Districts ranked in ascending order by fire incidence with regard to fire incidence (2018) per 10,000 household.

Dataset: Risk areas

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `Department of City Law Enforcement, BMA`

Publication year: `2019`

Target year: `2019`

Acquisition date (yyyymmdd): `20200511`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Notes: `Only one district has 30 locations; most have below 20. Perhaps 15 would be a more meaningful target to aspire to? Alternately, number of reported incidents could be a more meaningful metric.`

Data location relative to project folder: `./data/Thai/_from BMA/20200511/Risk Areas _crime_ in Bangkok _improved_kn20200510.xlsx`

Number of locations with reported crime (2019)

The number of crime locations reported within each district was recorded, and subsequently evaluated against a target threshold.

Aligns with Sustainable Development Goals: 11, 13.

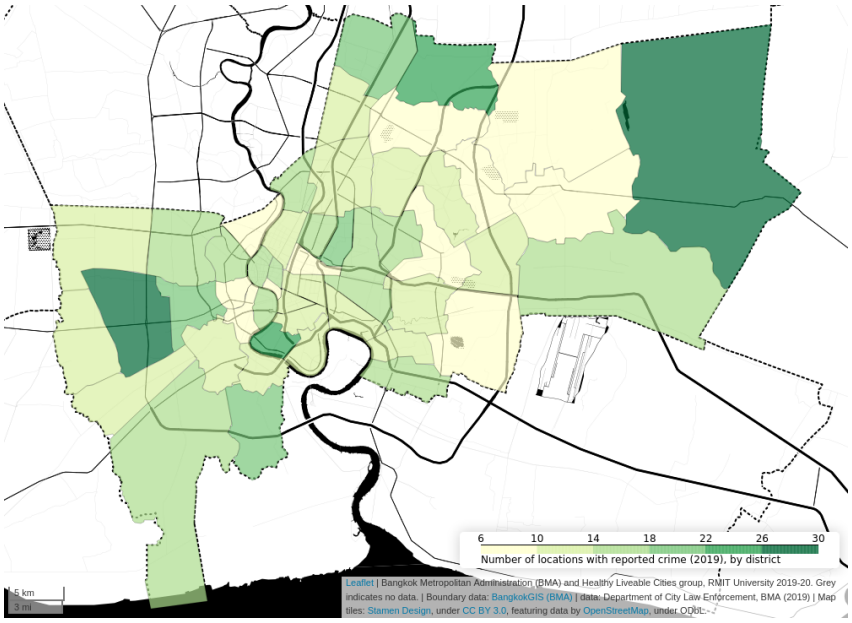


Fig. 141: Number of locations with reported crime (2019), by district

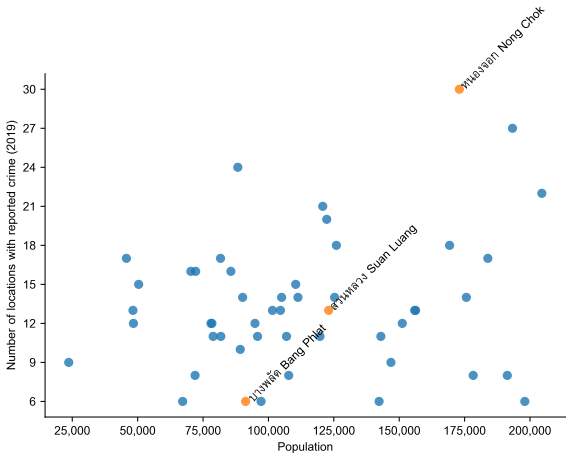


Fig. 142: Scatterplot of Locations with reported crime by population for districts.

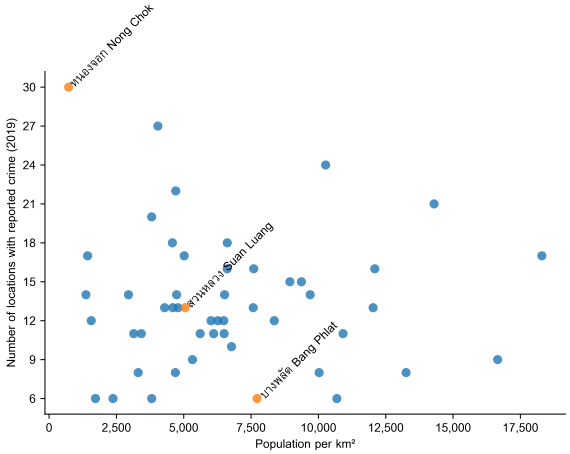


Fig. 143: Scatterplot of Locations with reported crime by population density for districts.

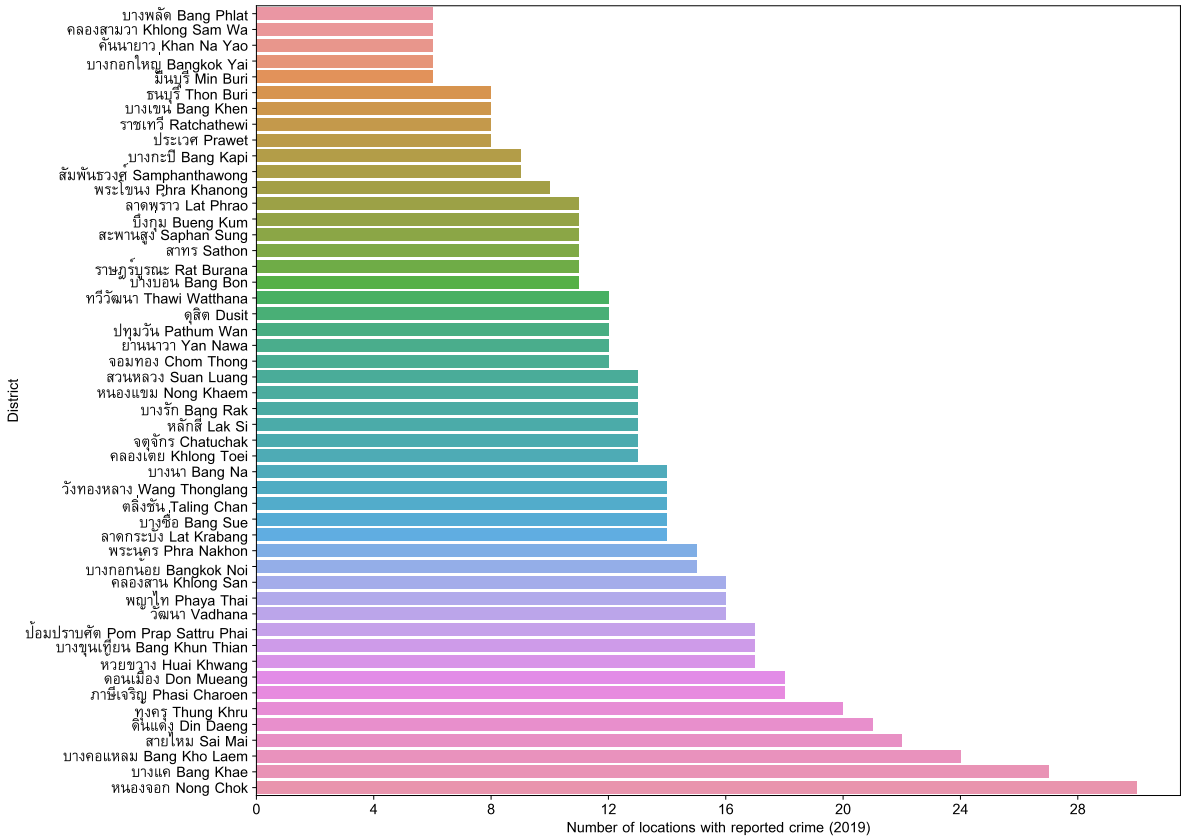


Fig. 144: Districts ranked in ascending order by locations with reported crime with regard to number of locations with reported crime (2019).

Number of locations with reported road accidents (2019)

The number of road accidents locations reported within each district was recorded, and subsequently evaluated against a target threshold.

Aligns with Sustainable Development Goals: 11, 13.

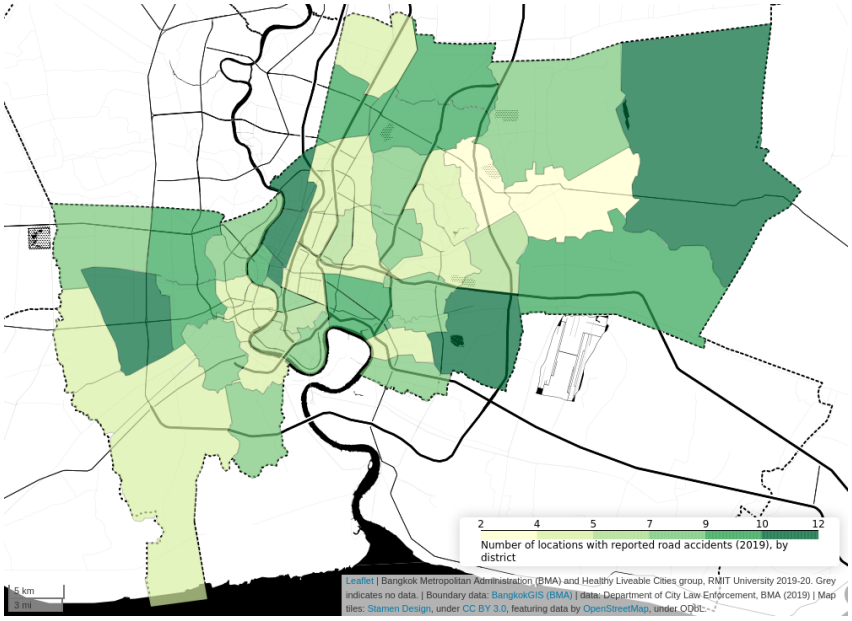


Fig. 145: Number of locations with reported road accidents (2019), by district

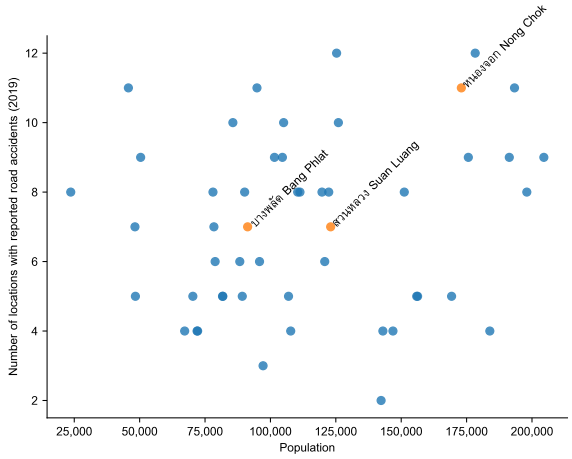


Fig. 146: Scatterplot of Locations with reported road accidents by population for districts.

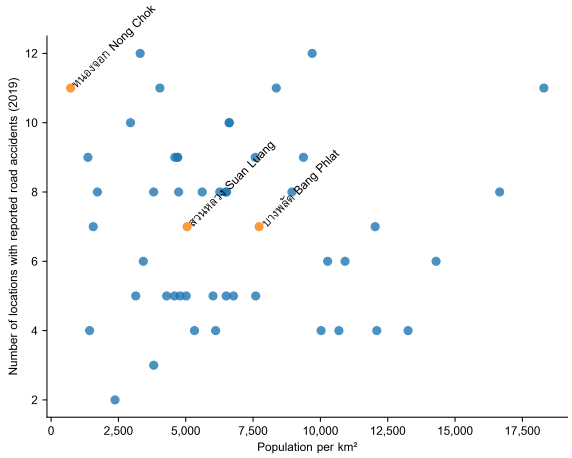


Fig. 147: Scatterplot of Locations with reported road accidents by population density for districts.

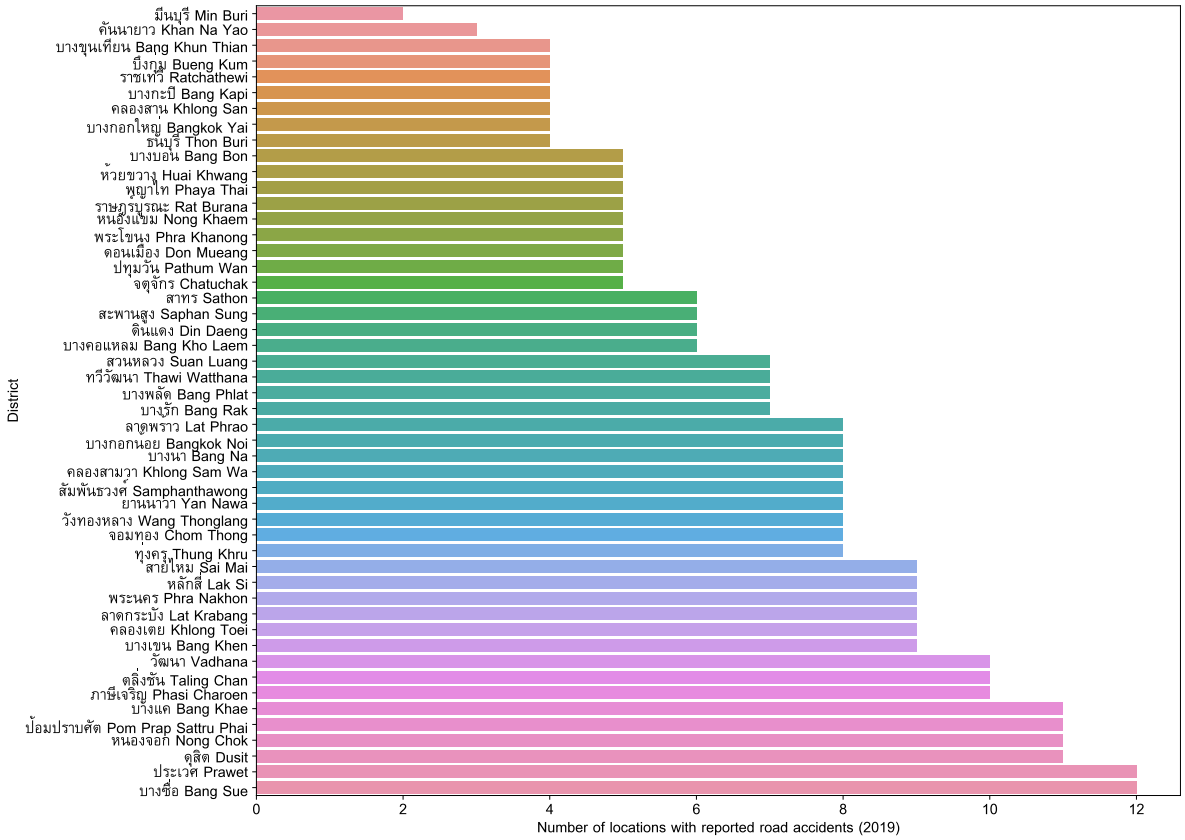


Fig. 148: Districts ranked in ascending order by locations with reported road accidents with regard to number of locations with reported road accidents (2019).

2.4 Health-promoting environments

2.4.1 Green space, pocket parks

พื้นที่สีเขียว/สวนหย่อม

Public Parks and open spaces refer to official and unofficial land reserved for sports and recreation, preserving the natural environment and providing green space for urban flood management. The development of green areas, gardens and open spaces can increase the value of land, for example by adding amenities to create happiness or enjoyment for the public, or promoting activities to strengthen family relationships within an area. Examples of such sites include botanical parks, sports fields, children's playgrounds, marshes with water sports / fishing / community swimming pools, camps, picnic activities for families, dog parks.

Dataset: Green areas

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `BMA`

Publication year: `2019`

Target year: `2019`

Acquisition date (yyyymmdd): `20190930`

Licence: `none specified`

Licence URL: `Website 203.155.220.220/parks`

Date type: `integer`

Scale / Resolution: `area summary`

Notes: `Only two districts have 12 locations; perhaps <= 10 would be a more aspirational target.`

Data location relative to project folder: `./data/Thai/_from BMA/20190930/transfer_1730651_files_296a713c/Green area in BKK by district 2019_kn20190923.xlsx`

Total public green area percent (2019)

The total area of green space reported within each district was recorded, and subsequently evaluated against target thresholds with regard to total area, and per capita.

Aligns with Sustainable Development Goals: 3, 11, 13, 15.

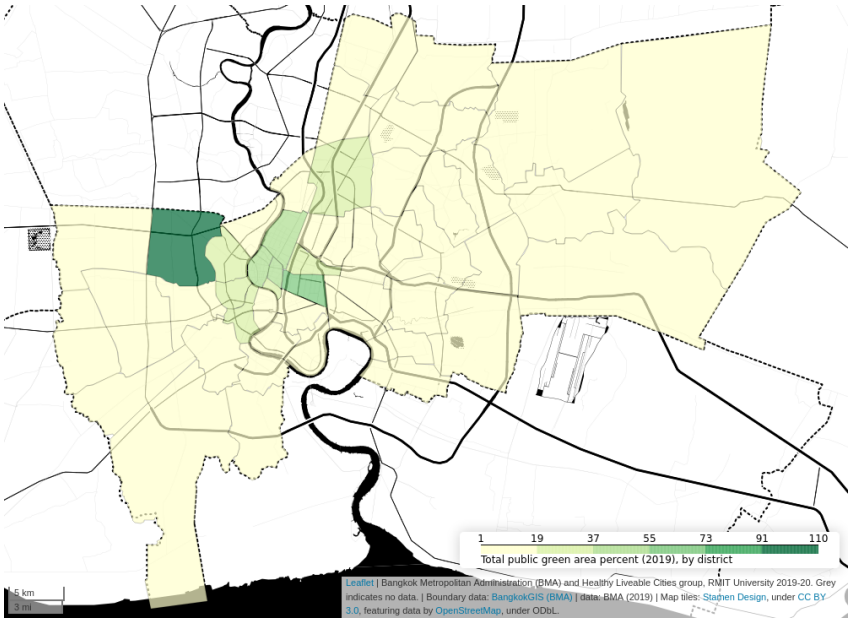


Fig. 149: Total public green area percent (2019), by district

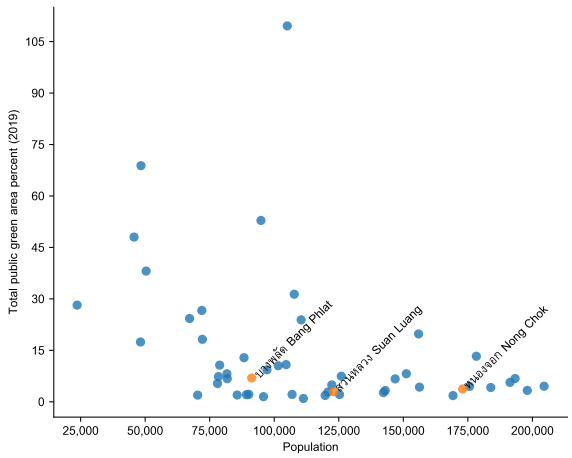


Fig. 150: Scatterplot of Total public green space percent by population for districts.

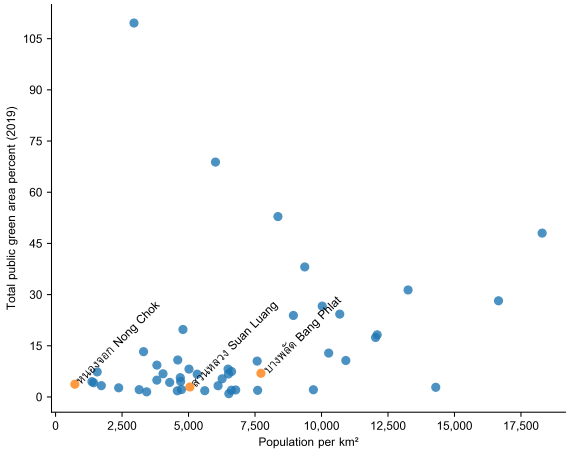


Fig. 151: Scatterplot of Total public green space percent by population density for districts.

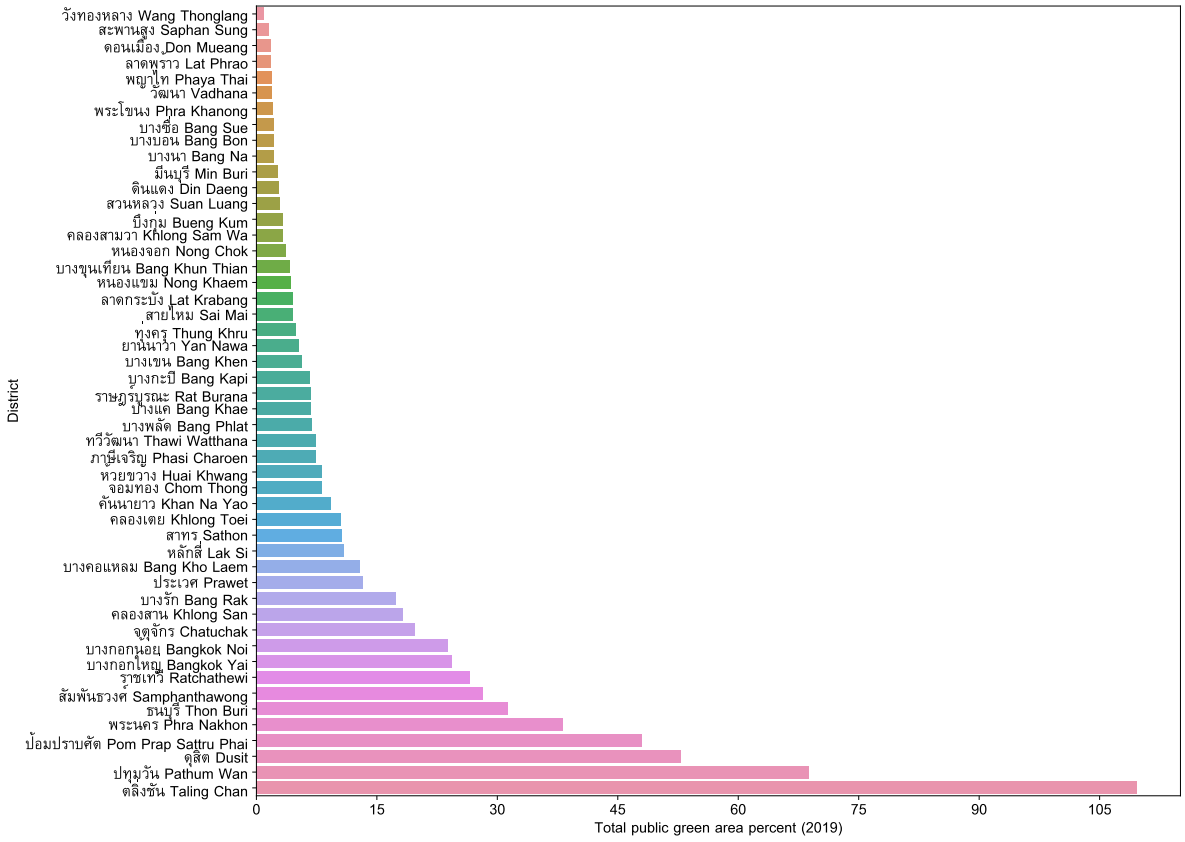


Fig. 152: Districts ranked in ascending order by total public green space percent with regard to total public green area percent (2019).

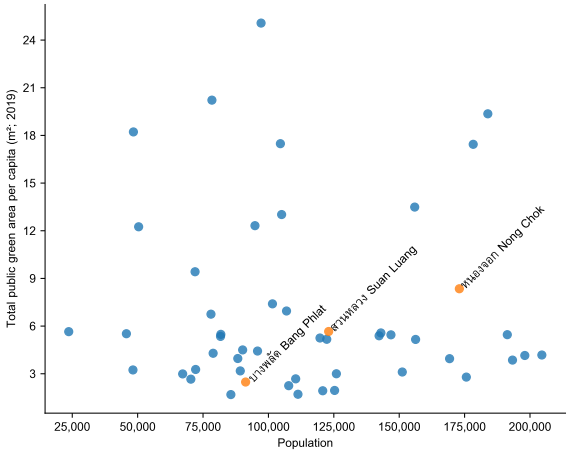


Fig. 153: Scatterplot of Green space per capita (sqm) by population for districts.

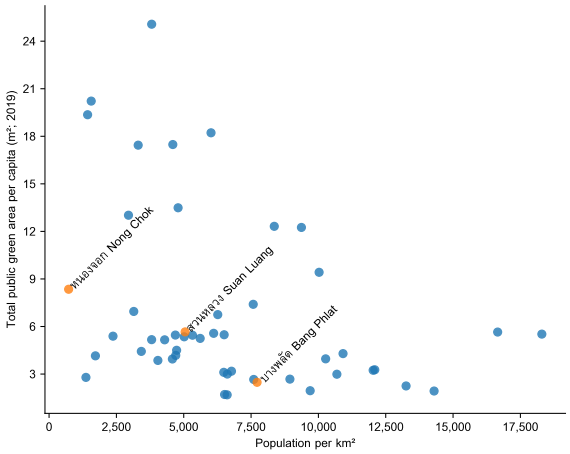


Fig. 154: Scatterplot of Green space per capita (sqm) by population density for districts.

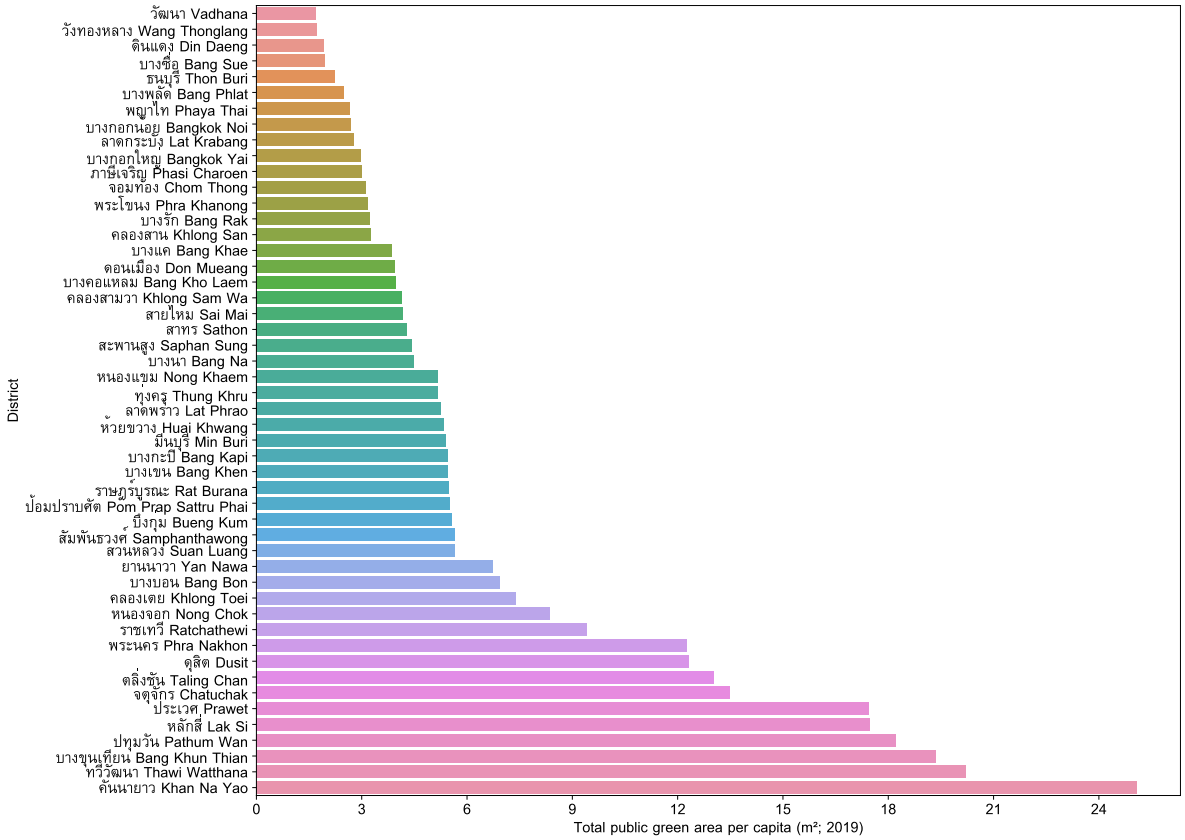


Fig. 155: Districts ranked in ascending order by green space per capita (sqm) with regard to total public green area per capita (m^2; 2019).

Number of green areas (2019)

The number of green areas within each district was recorded. Classification was based on a typology of 9 kinds of green space: outdoor stadium, golf course, water source, lowland, open space, big tree areas, agricultural areas, aquaculture areas and other areas.

Aligns with Sustainable Development Goals: 3, 11, 13, 15.

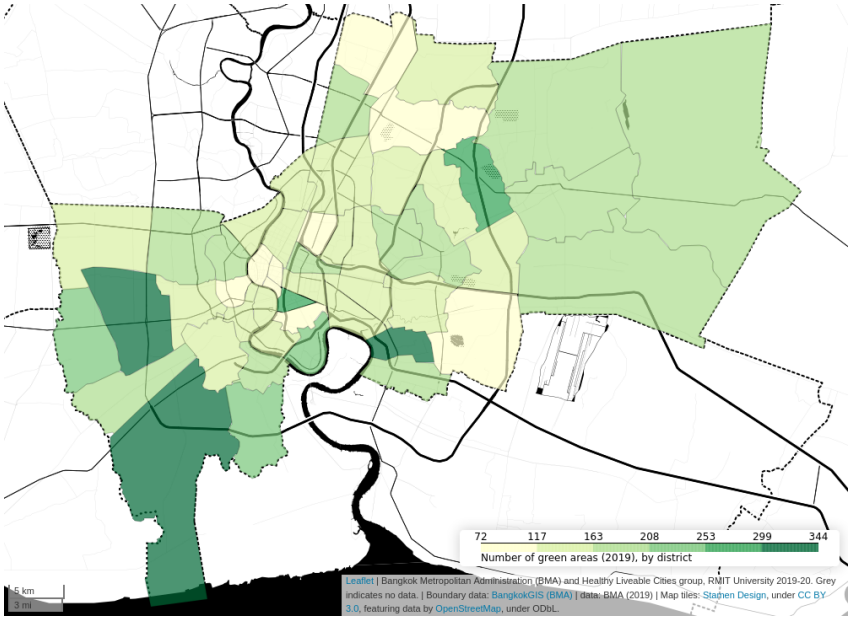


Fig. 156: Number of green areas (2019), by district

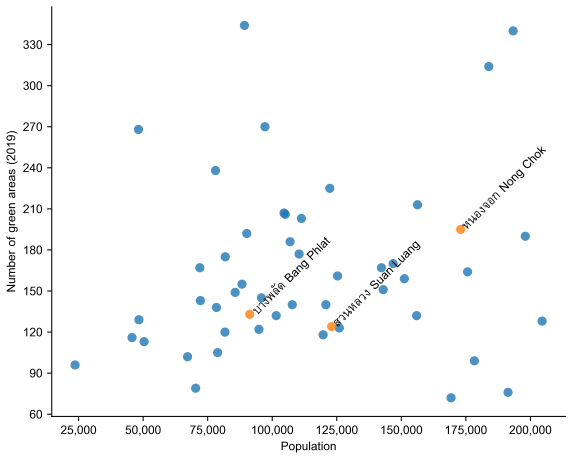


Fig. 157: Scatterplot of Total number of green areas (places) by population for districts.

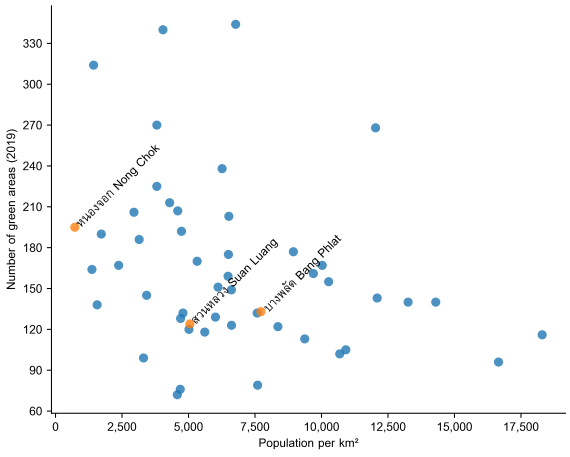


Fig. 158: Scatterplot of Total number of green areas (places) by population density for districts.

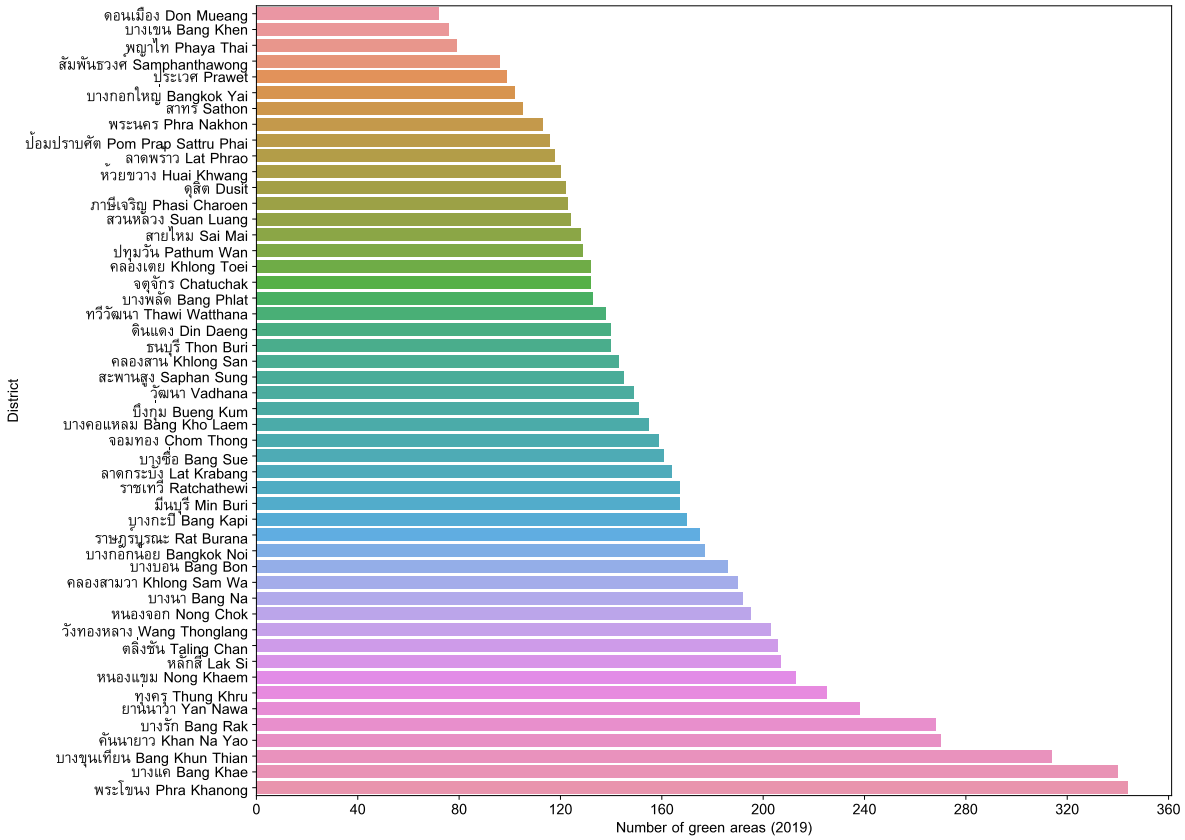


Fig. 159: Districts ranked in ascending order by total number of green areas (places) with regard to number of green areas (2019).

2.4.2 Greater tree coverage to provide shade

ต้นไม้ที่ให้ร่มเงาในวงกว้าง

Greater tree coverage refers to canopy trees, being large trees with thick canopies or foliage coverings.

Dataset: Normalised Difference Vegetation Index

Landsat 8 Collection 1 Tier 1 Annual NDVI Composite data (LANDSAT/LC08/C01/T1_ANNUAL_NDVI) was retrieved using Google Earth Engine for Bangkok for 2019, using the bounding box WGS84 coordinates [100.327866596872, 13.4851864441217, 100.938637619401, 13.9551828398924]. Normalized Difference Vegetation Index (NDVI) was generated from the Near-IR and Red bands of each scene as (NIR - Red) / (NIR + Red), and ranges in value from -1.0 to 1.0.

Data source: `Landsat-8 data courtesy of the U.S. Geological Survey, processed using Google Earth Engine`

URL: `https://developers.google.com/earth-engine/datasets/catalog/LANDSAT_LC08_C01_T1_ANNUAL_NDVI`

Publication year: `2020`

Target year: `2019`

Acquisition date (yyyymmdd): `20200722`

Licence: `none specified`

Spatial reference (EPSG code): `4326.0`

Date type: `raster:float64`

Scale / Resolution: `30`

Notes: `Public domain; give credit to USGS and Google Earth Engine.`

Data location relative to project folder: `./data/International/Google EarthEngine/LANDSAT_LC08_C01_T1_ANNUAL_NDVI_20190101_20191231.tif`

Normalised Difference Vegetation Index (NDVI, annual mean; 2019)

The mean Normalized Difference Vegetation Index (NDVI) for each district and subdistrict was recorded

Aligns with Sustainable Development Goals: 3, 11, 13, 15.

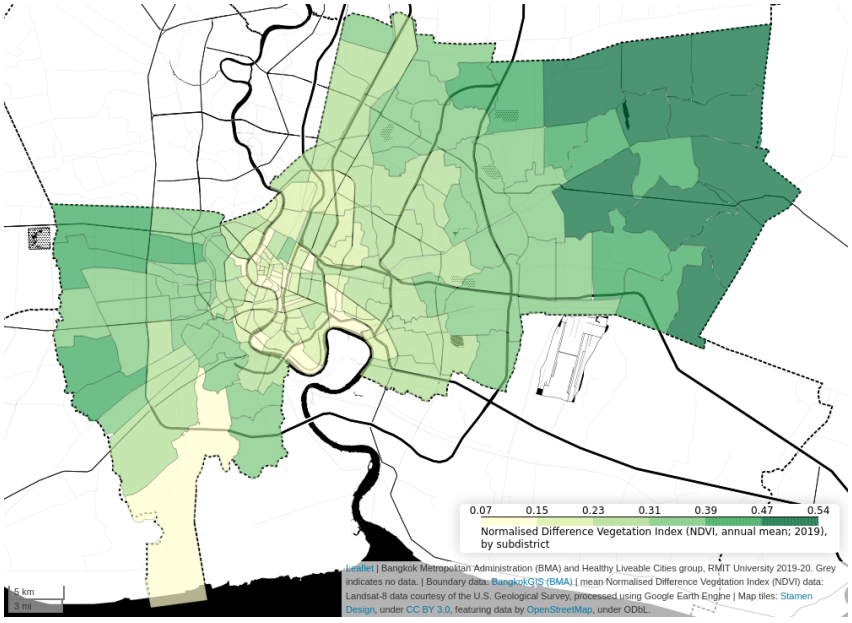


Fig. 160: Normalised Difference Vegetation Index (NDVI, annual mean; 2019), by subdistrict

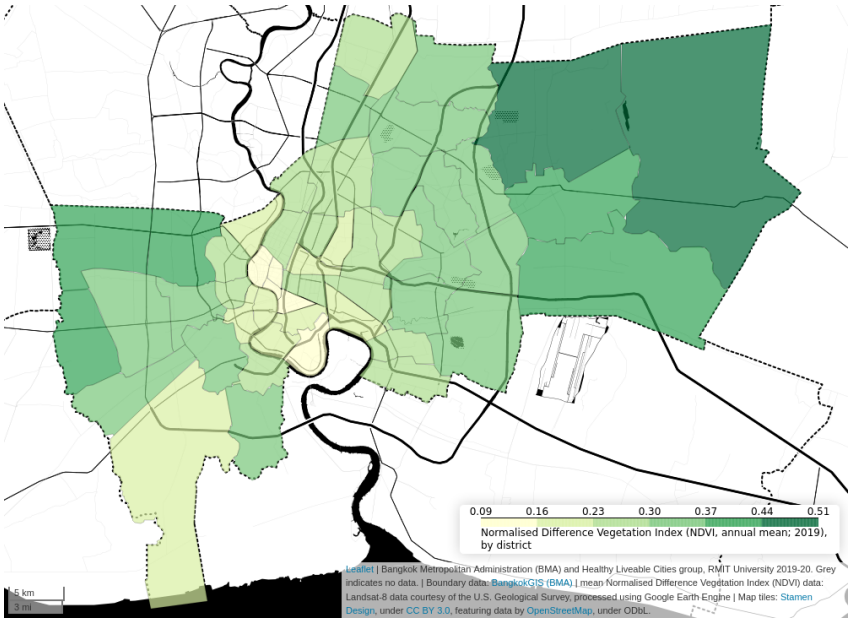


Fig. 161: Normalised Difference Vegetation Index (NDVI, annual mean; 2019), by district

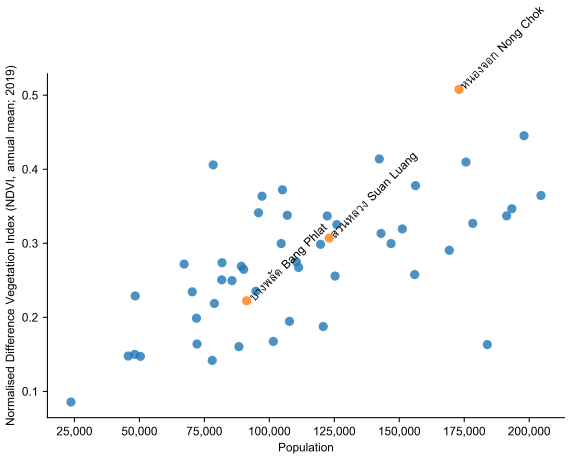


Fig. 162: Scatterplot of mean Normalised Difference Vegetation Index (NDVI) by population for districts.

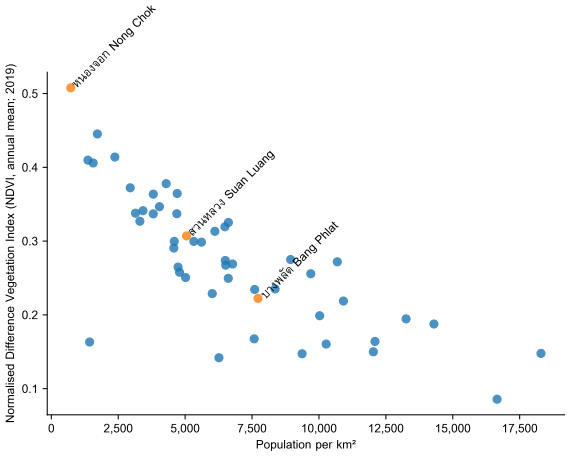


Fig. 163: Scatterplot of mean Normalised Difference Vegetation Index (NDVI) by population density for districts.

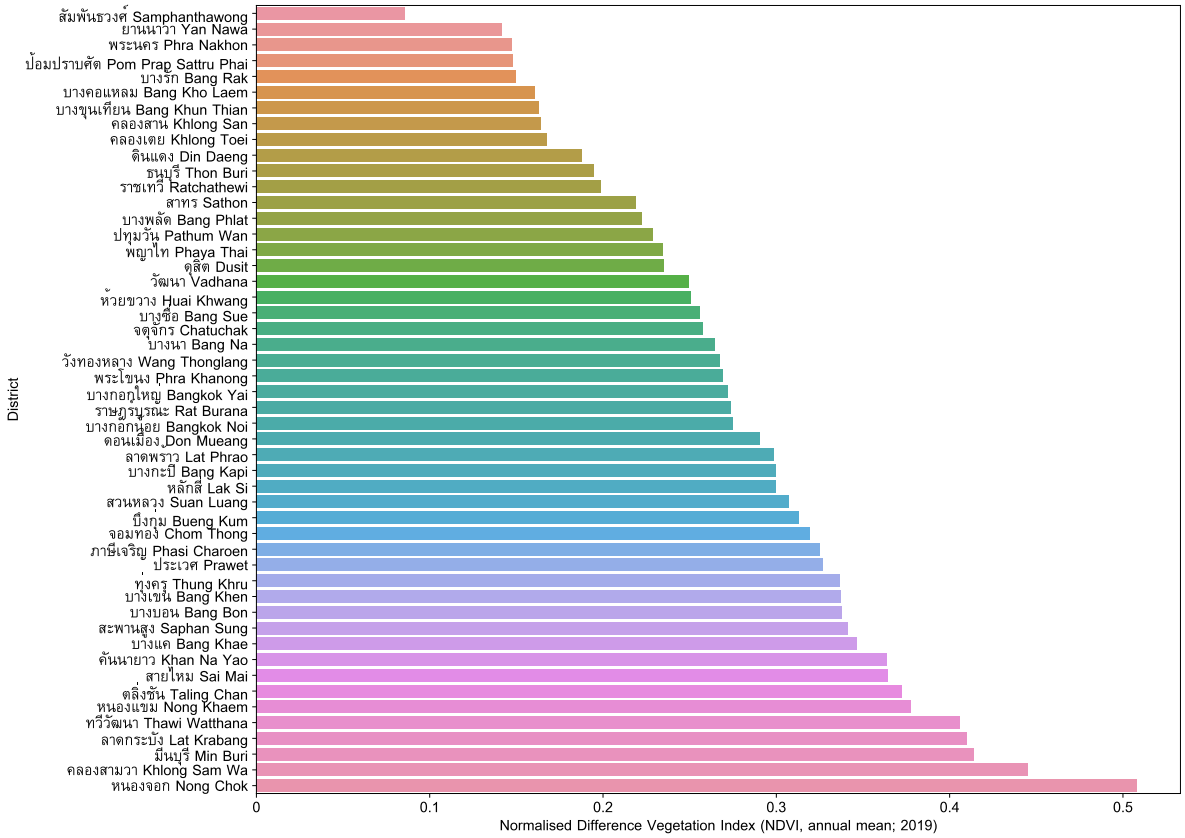


Fig. 164: Districts ranked in ascending order by mean normalised difference vegetation index (ndvi) with regard to normalised difference vegetation index (ndvi, annual mean; 2019).

Dataset: Enhanced vegetation index

Landsat 8 Collection 1 Tier 1 Annual EVI Composite data (LANDSAT/LC08/C01/T1_ANNUAL_EVI) was retrieved using Google Earth Engine for Bangkok for 2019, using the bounding box WGS84 coordinates [100.327866596872, 13.4851864441217, 100.938637619401, 13.9551828398924]. The Enhanced Vegetation Index (EVI) is generated from the Near-IR, Red and Blue bands of each scene, and ranges in value from -1.0 to 1.0. See Huete et al. (2002) for details.

Data source: `Landsat-8 data courtesy of the U.S. Geological Survey, processed using Google Earth Engine`

URL: `https://developers.google.com/earth-engine/datasets/catalog/LANDSAT_LC08_C01_T1_ANNUAL_EVI`

Publication year: `2020`

Target year: `2019`

Acquisition date (yyyymmdd): `20200722`

Licence: `none specified`

Spatial reference (EPSG code): `4326.0`

Date type: `raster:float64`

Scale / Resolution: `30`

Notes: `Public domain; give credit to USGS and Google Earth Engine.`

Data location relative to project folder: `./data/International/Google EarthEngine/LANDSAT_LC08_C01_T1_ANNUAL_EVI_20190101_20191231.tif`

Enhanced Vegetation Index (EVI, annual mean; 2019)

The mean Enhanced Vegetation Index (EVI) for each district and subdistrict was recorded

Aligns with Sustainable Development Goals: 3, 11, 13, 15.

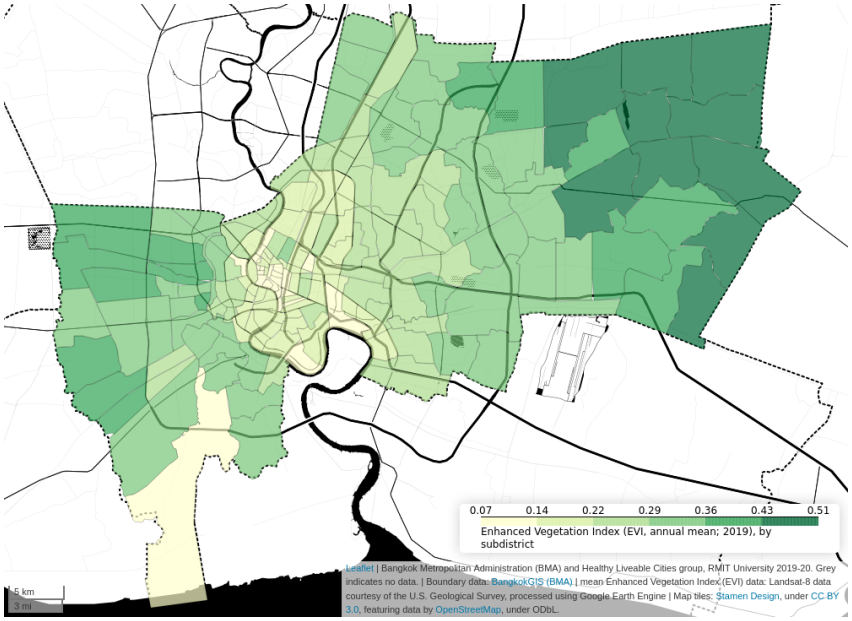


Fig. 165: Enhanced Vegetation Index (EVI, annual mean; 2019), by subdistrict

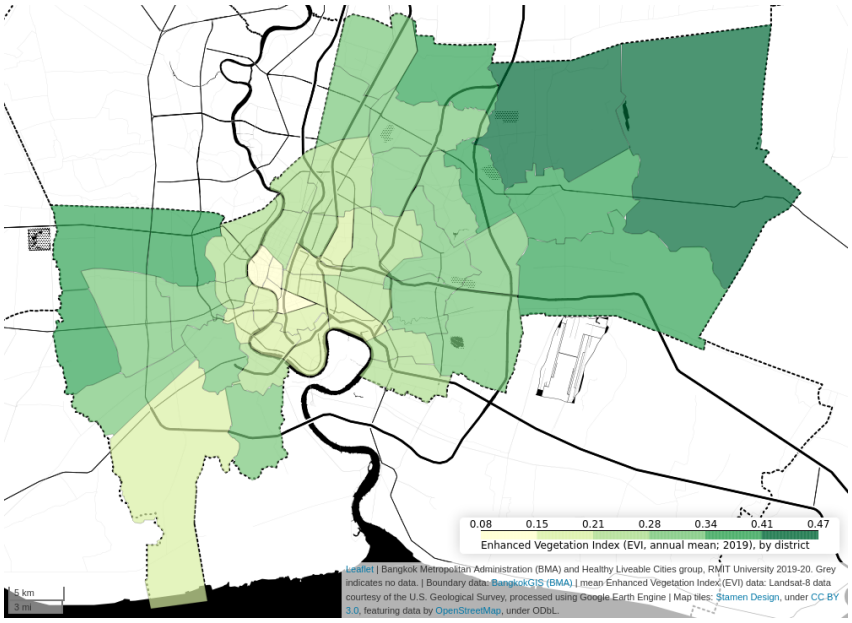


Fig. 166: Enhanced Vegetation Index (EVI, annual mean; 2019), by district

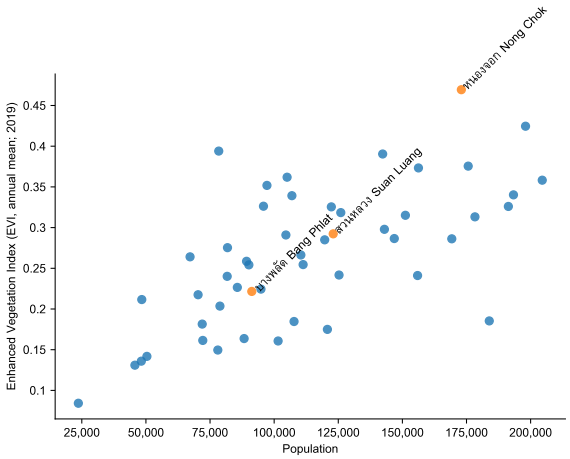


Fig. 167: Scatterplot of mean Enhanced Vegetation Index (EVI) by population for districts.

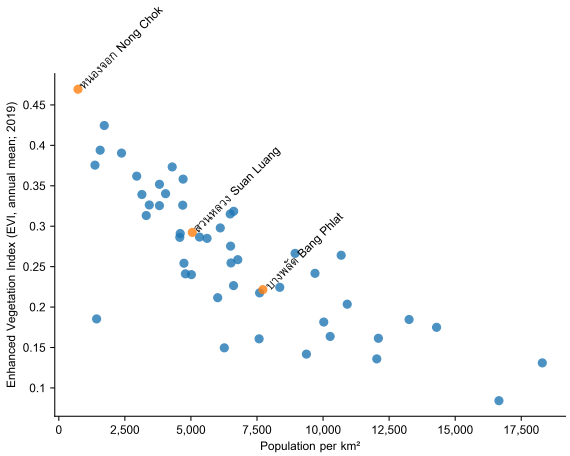


Fig. 168: Scatterplot of mean Enhanced Vegetation Index (EVI) by population density for districts.

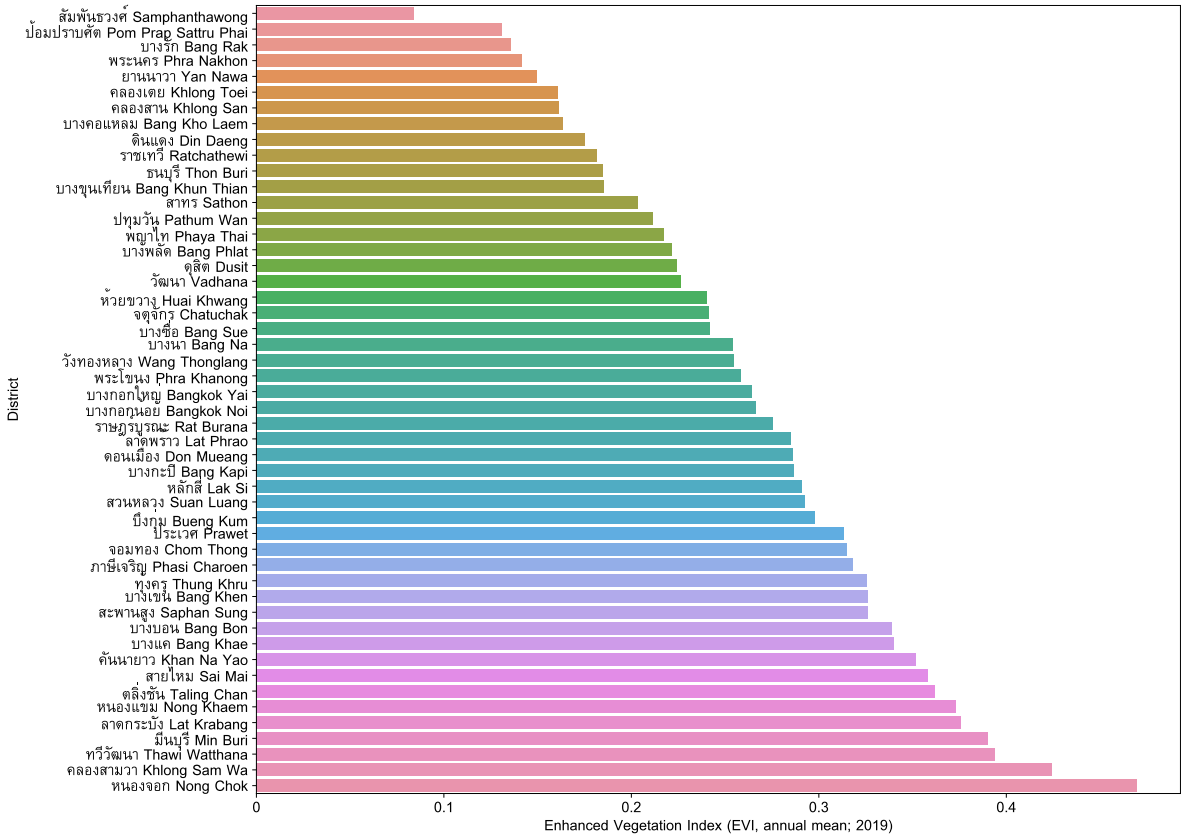


Fig. 169: Districts ranked in ascending order by mean enhanced vegetation index (evi) with regard to enhanced vegetation index (evi, annual mean; 2019).

Dataset: Fraction of Vegetation Cover

A modelled fraction of vegetation cover (FCOVER, V2) 1km grid data product based on Copernicus satellite imagery targetting 20 December 2018 was downloaded in NetCDF (.nc) format. Using the ESA SNAP software, a GeoTiff (.tif) excerpt was taken for the Bangkok region. Band 1 of this satellite data product represents the fraction of vegetation cover. Data values ranging from 0 to 250 are to be transformed to a 0 to 1 range to represent the fraction of vegetation cover within each grid portion. Cell values of 255 represent no data, and were excluded.

Data source: `Copernicus Service Information`

URL: `https://land.copernicus.eu/global/products/fcover`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190913`

Licence: `Free, full and open access for lawful usage, with attribution`

Licence URL: `https://sentinel.esa.int/documents/247904/690755/Sentinel_Data_Legal_Notice`

Spatial reference (EPSG code): `4326.0`

Date type: `raster:float64`

Scale / Resolution: `1000`

Data location relative to project folder: `./data/International/EC-JRC/Copernicus/subset_0_of_c_gls_FCOVER-RT6_201812200000_GLOBE_PROBAV_V2.tif`

Vegetation Percent (mean; December 2018)

The estimated percentage of vegetation cover within each analysis area was calculated by first scaling the raster grid cell values by 100/250 (a scale factor of 0.4) and then taking the mean (average) of all intersecting grid cells.

Aligns with Sustainable Development Goals: 3, 11, 13, 15.

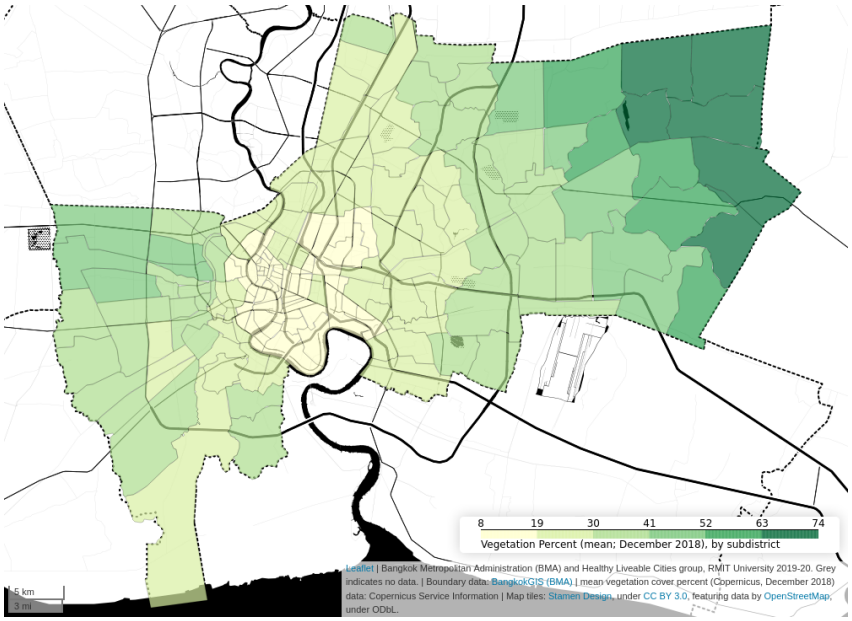


Fig. 170: Vegetation Percent (mean; December 2018), by subdistrict

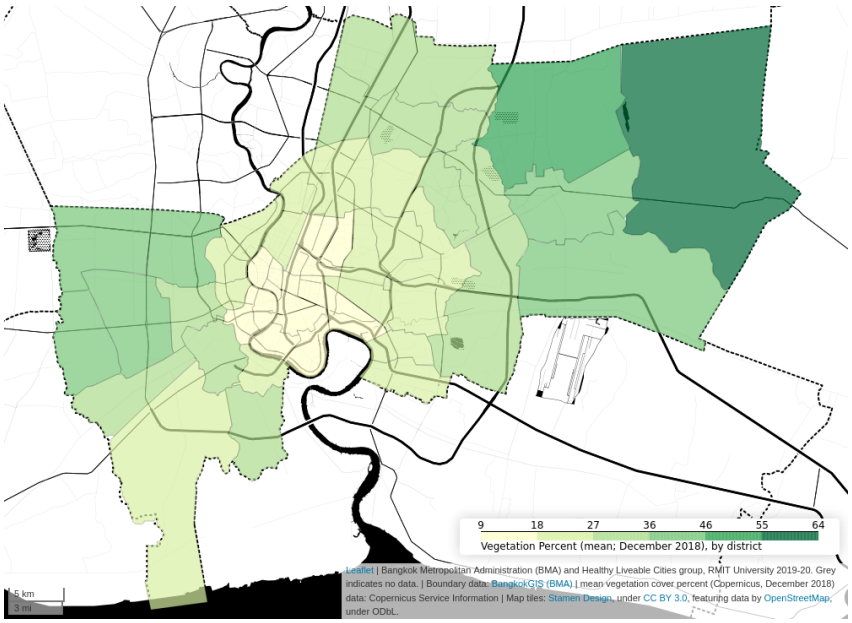


Fig. 171: Vegetation Percent (mean; December 2018), by district

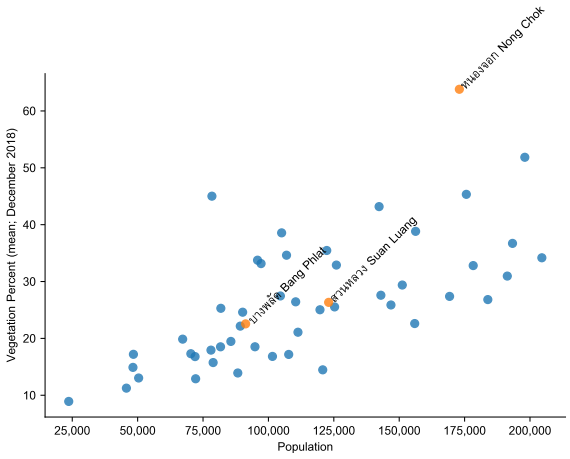


Fig. 172: Scatterplot of mean vegetation cover percent (Copernicus, December 2018) by population for districts.

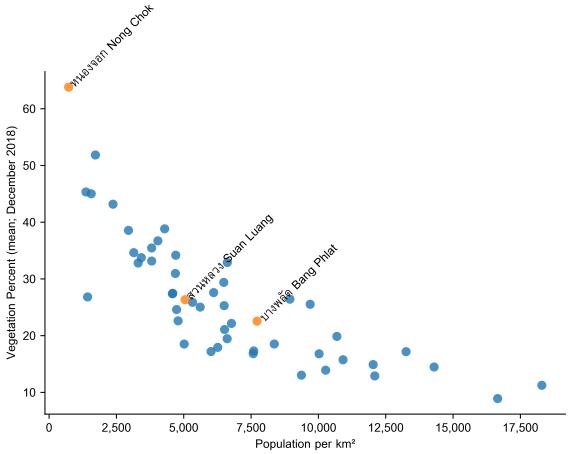


Fig. 173: Scatterplot of mean vegetation cover percent (Copernicus, December 2018) by population density for districts.

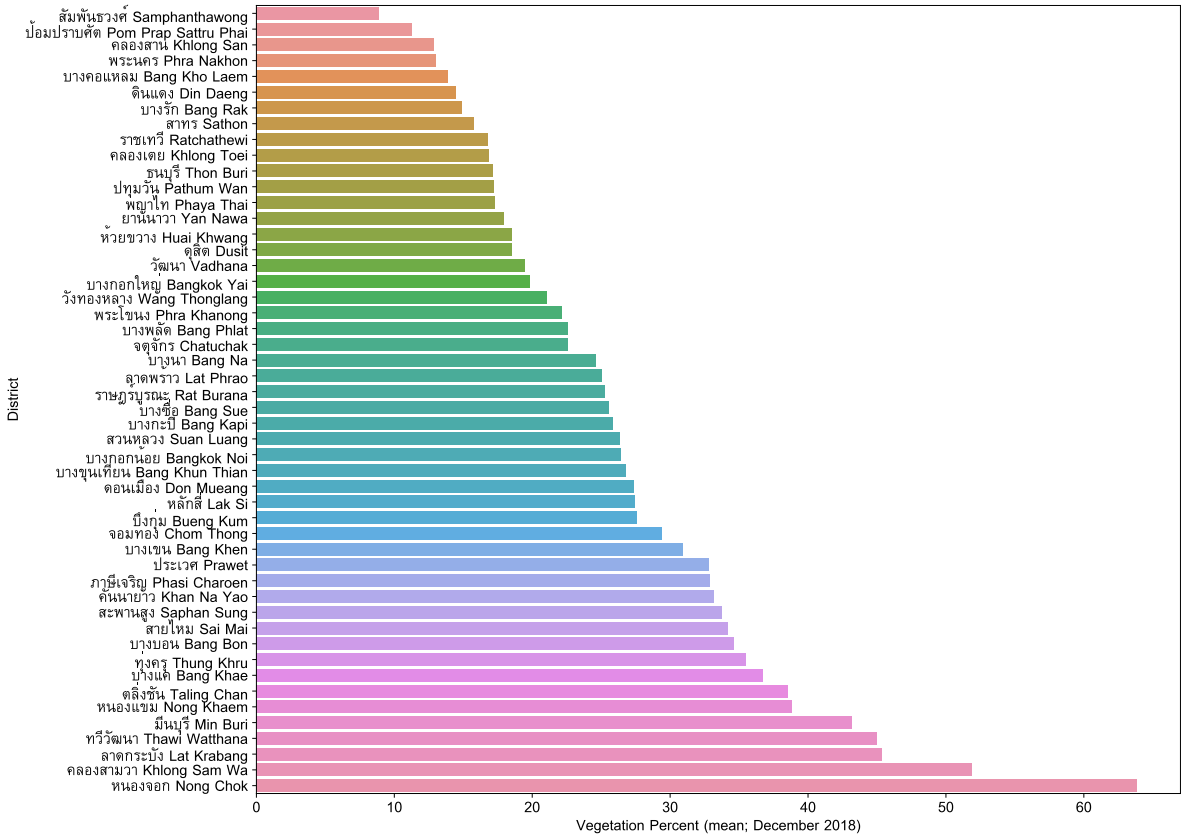


Fig. 174: Districts ranked in ascending order by mean vegetation cover percent (copernicus, december 2018) with regard to vegetation percent (mean; december 2018).

Vegetation Percent (standard deviation; December 2018)

The estimated standard deviation of percentage of vegetation cover within each analysis area was calculated by first scaling the raster grid cell values by 100/250 (a scale factor of 0.4) and then taking the standard deviation of all intersecting grid cells. This is a measure of the degree to wich estimates vary across a particular area, and is a useful contextual measure to accompany the average vegetation percent for the area.

Aligns with Sustainable Development Goals: 3, 11, 13, 15.

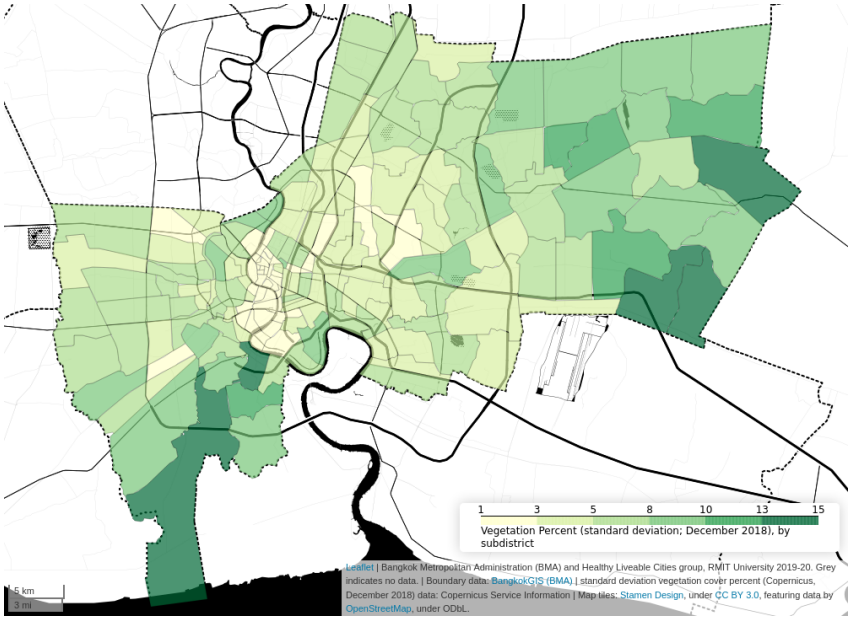


Fig. 175: Vegetation Percent (standard deviation; December 2018), by subdistrict

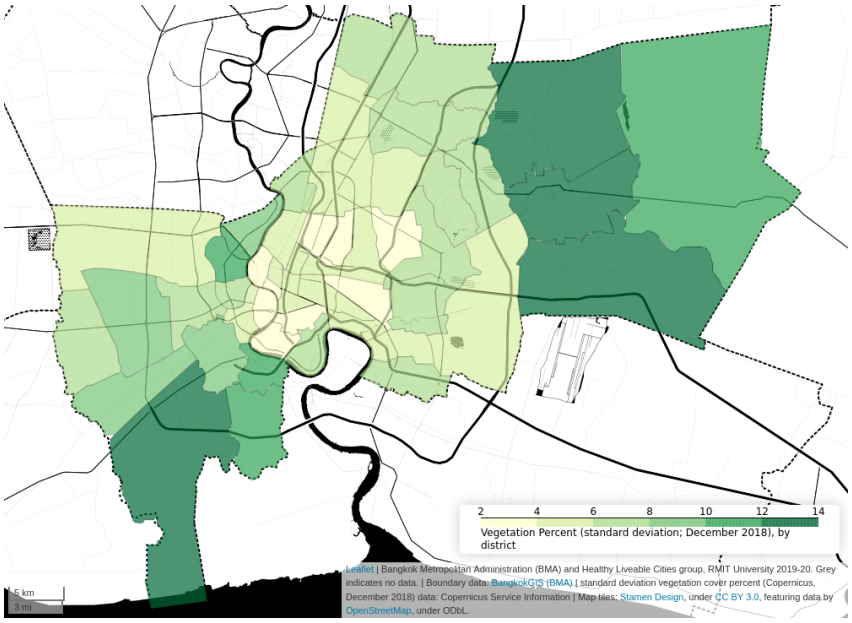


Fig. 176: Vegetation Percent (standard deviation; December 2018), by district

2.4.3 Areas for passive recreation and physical activity

พื้นที่สำหรับพักผ่อนและออกกำลังกาย

Passive recreation means recreational activities that do not require facilities such as a stadium or pavilion (walking, picnic, camping, swimming, biking, hiking, observing and photographing nature). Physical activity means an individual or team activity that has a structure that requires facilities, courses, courts, or special equipment (football, golf, tennis, et cetera).

Dataset: Public Open Space

A dataset of Areas of Public Open Space was derived from OpenStreetMap using a series of key-value pair tag queries in conjunction with morphological and heuristic criteria. [description to be updated]

Data source: `OpenStreetMap`

Publication year: `2019`

Target year: `2019`

Acquisition date (yyyymmdd): `20191007`

Licence: `ODbL`

Licence URL: `https://wiki.osmfoundation.org/wiki/Licence`

Scale / Resolution: `400`

Notes: `User contributed data; Please note licence implications involving usage of OSM data when combined with other data sets`

Data location relative to project folder: `./data/International/OSM/thailand-latest.20191007.osm.pbf`

Percentage of residents living within 400 metres of public open space (2019)

Accessibility within 400m was evaluated using the Python network analysis package Pandana for a series of sample points generated every 50 metres along the Bangkok OSM pedestrian network. Population weighted averages for the proportion of sample points having access in each subdistrict were used to estimate the measure.

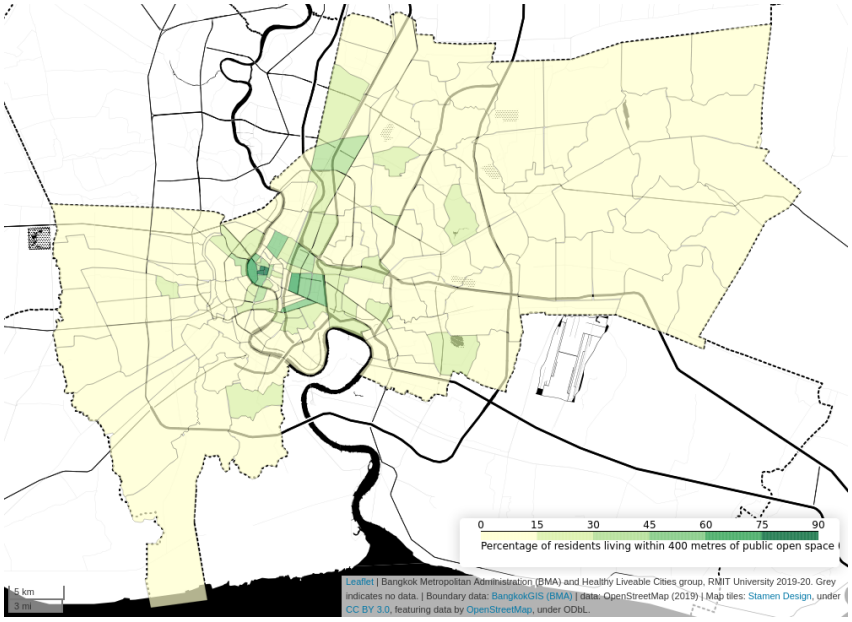


Fig. 177: Percentage of residents living within 400 metres of public open space (2019), by subdistrict

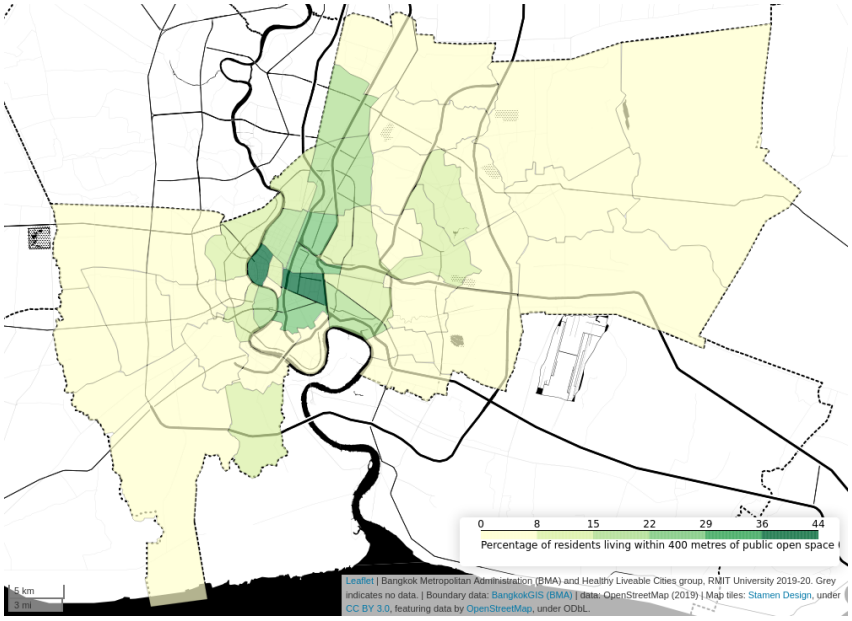


Fig. 178: Percentage of residents living within 400 metres of public open space (2019), by district

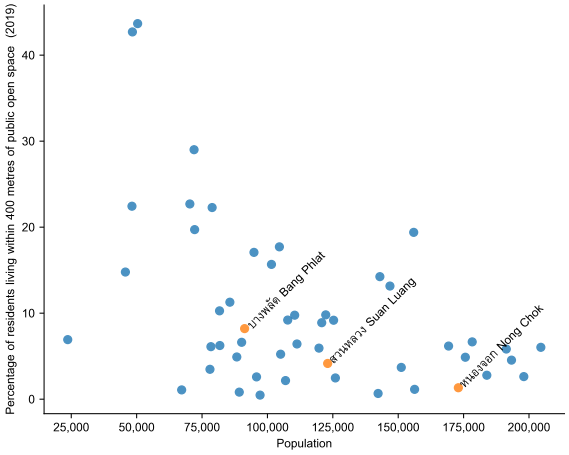


Fig. 179: Scatterplot of % living within 400 metres of public open space (OSM, 2019) by population for districts.

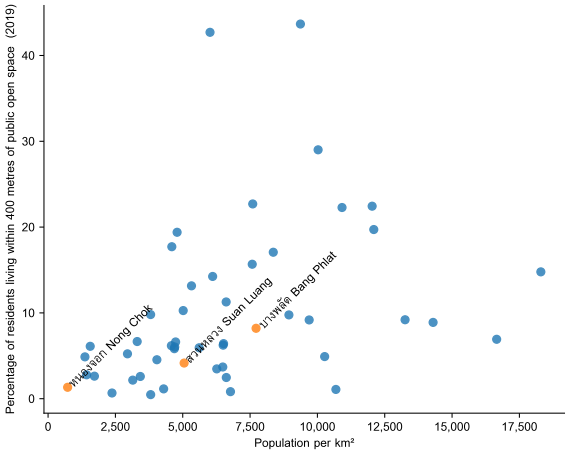


Fig. 180: Scatterplot of % living within 400 metres of public open space (OSM, 2019) by population density for districts.

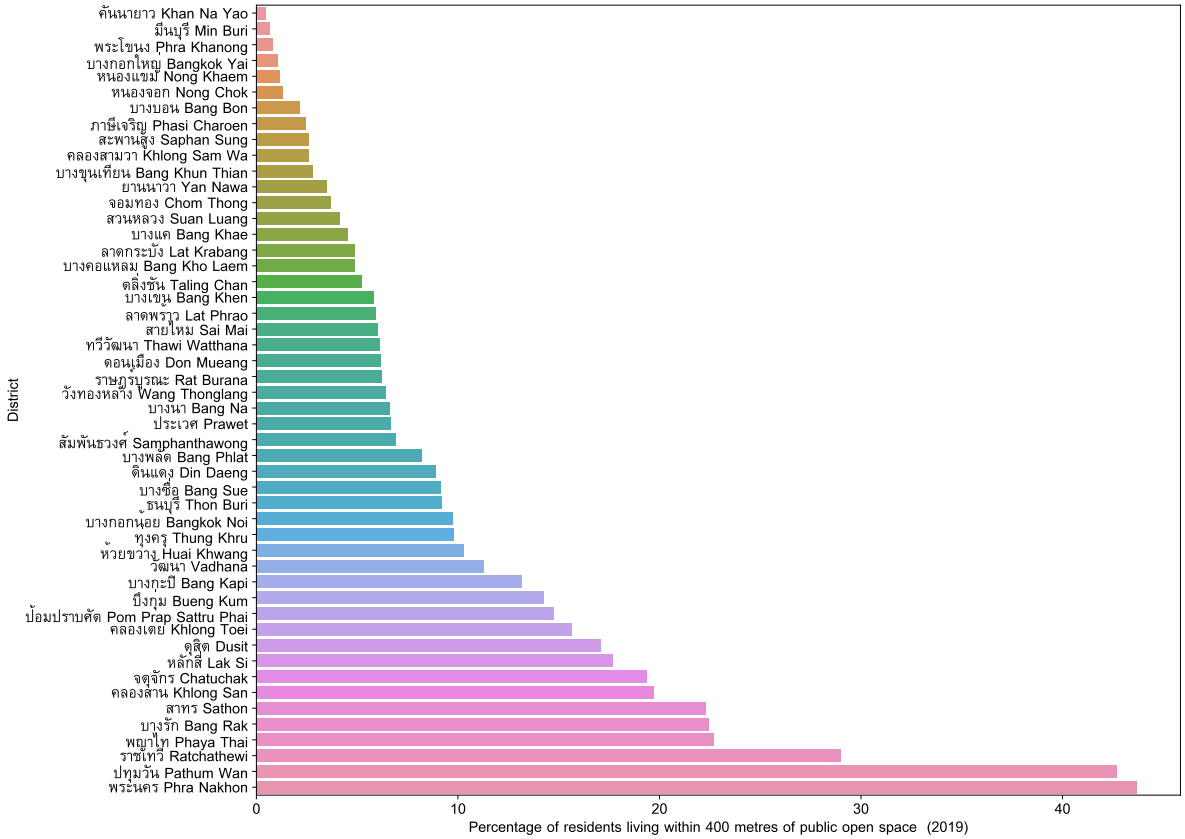


Fig. 181: Districts ranked in ascending order by % living within 400 metres of public open space (osm, 2019) with regard to percentage of residents living within 400 metres of public open space (2019).

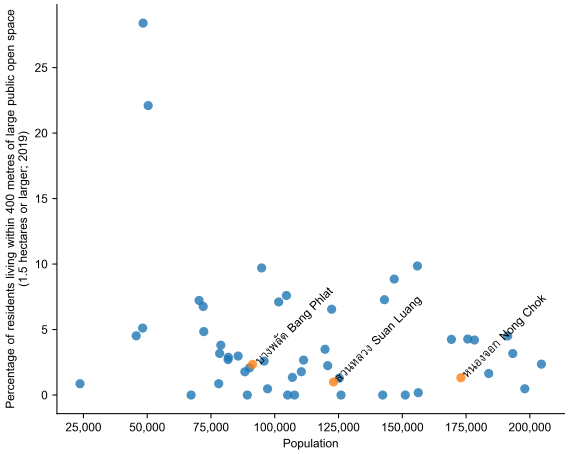


Fig. 182: Scatterplot of % living within 400 metres of large public open space (OSM, 2019) by population for districts.

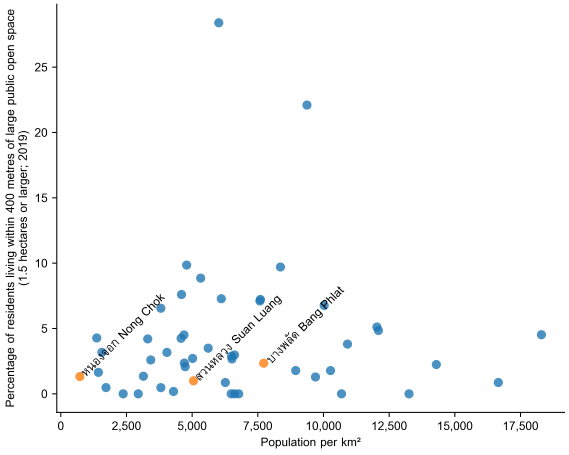


Fig. 183: Scatterplot of % living within 400 metres of large public open space (OSM, 2019) by population density for districts.

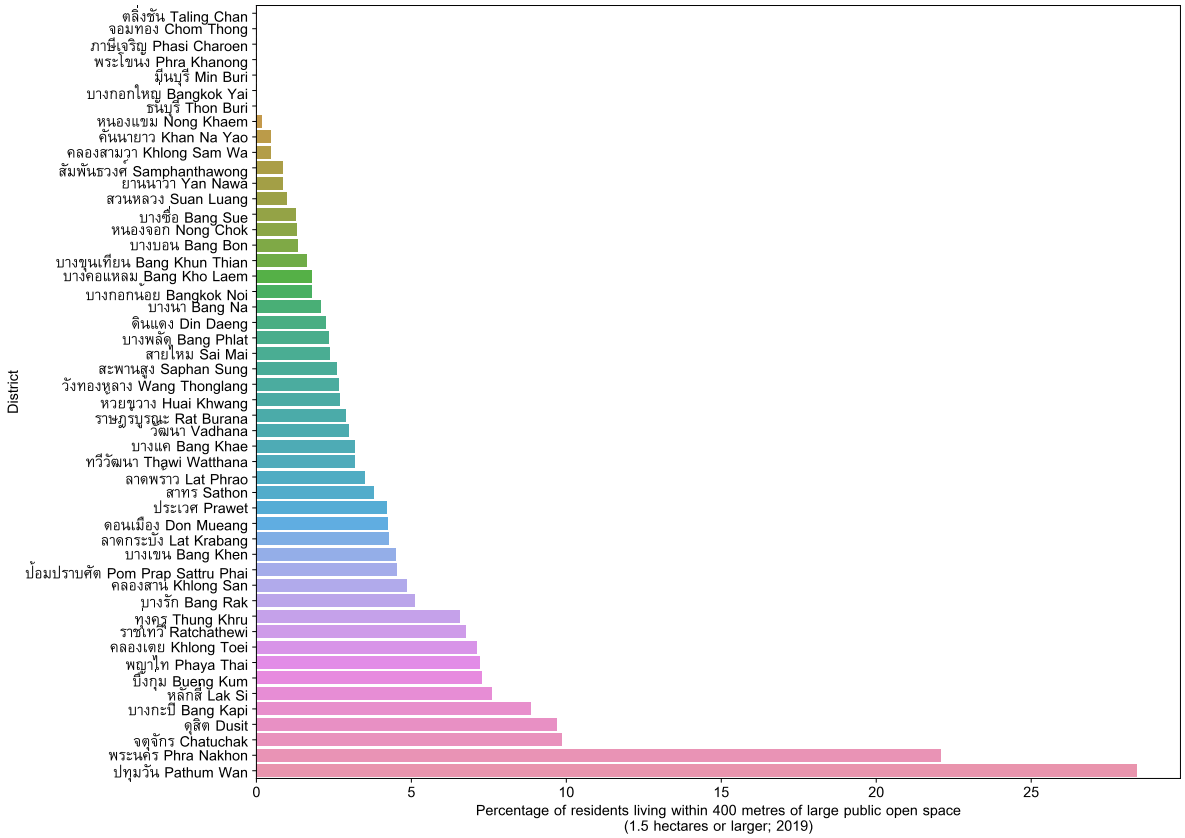


Fig. 184: Districts ranked in ascending order by % living within 400 metres of large public open space (osm, 2019) with regard to percentage of residents living within 400 metres of large public open space (1.5 hectares or larger; 2019).

2.4.4 Mass transit availability; connected public transport networks; increased provision of transit-oriented developments

ขนส่งมวลชนที่มีให้บริการ (เครือข่ายเชื่อมต่อ พัฒนาเพิ่มทางเลือก

Mass transportation systems refer to public transport in the metropolitan area, usually consisting of buses subway and elevated trains. Convenient public transportation access means refers to public transport stops accessible within a walkable distance (e.g. 500 metres) of a reference point, such as homes, schools, workplaces, markets, etc. Additional characteristics includ: A) Public transportation can reach people with special needs, including people with physical disabilities and / or hearing impairments, including people with temporary disabilities. The elderly, children and others in vulnerable situations; B. Frequent public transport services during peak travel times; C. Stations or stops showing a safe and convenient environment

Dataset: Public Transport

Combined BMA railway stations (BTS, MRT, airtportlink, and other train stations; BMA, 2014) were analysed for Accessibility using an OSM pedestrian network, derived using OSMnx.

Data source: `BangkokGIS (BMA)`

Publication year: `2014`

Target year: `2014`

Acquisition date (yyyymmdd): `20181210`

Licence: `none specified`

Spatial reference (EPSG code): `32647.0`

Date type: `vector`

Scale / Resolution: `800`

Percentage of residents living within 800 metres of a train station (2014)

Accessibility within 800m was evaluated using the Python network analysis package Pandana for a series of sample points generated every 50 metres along the Bangkok OSM pedestrian network. Population weighted averages for the proportion of sample points having access in each subdistrict were used to estimate the measure.

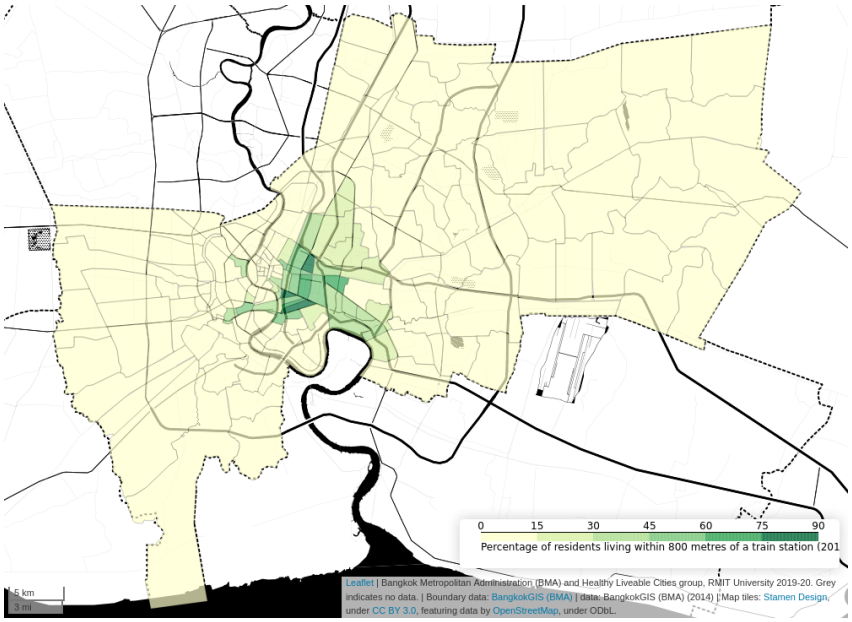


Fig. 185: Percentage of residents living within 800 metres of a train station (2014), by subdistrict

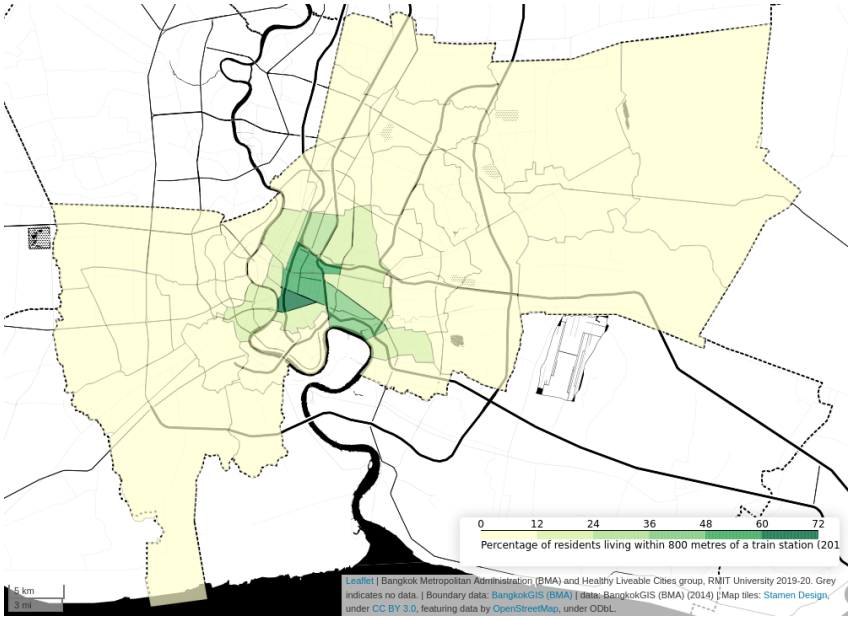


Fig. 186: Percentage of residents living within 800 metres of a train station (2014), by district

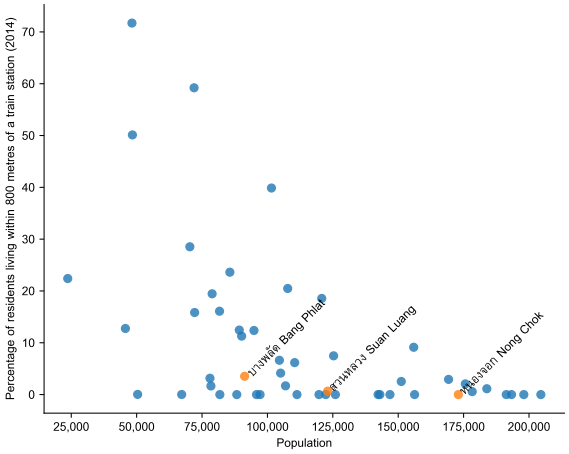


Fig. 187: Scatterplot of % living within 800 metres by population for districts.

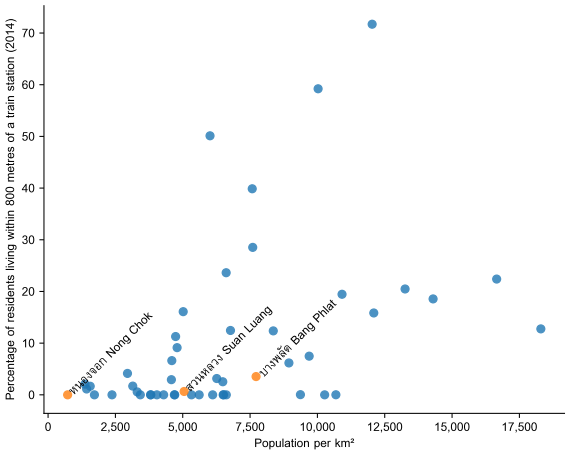


Fig. 188: Scatterplot of % living within 800 metres by population density for districts.

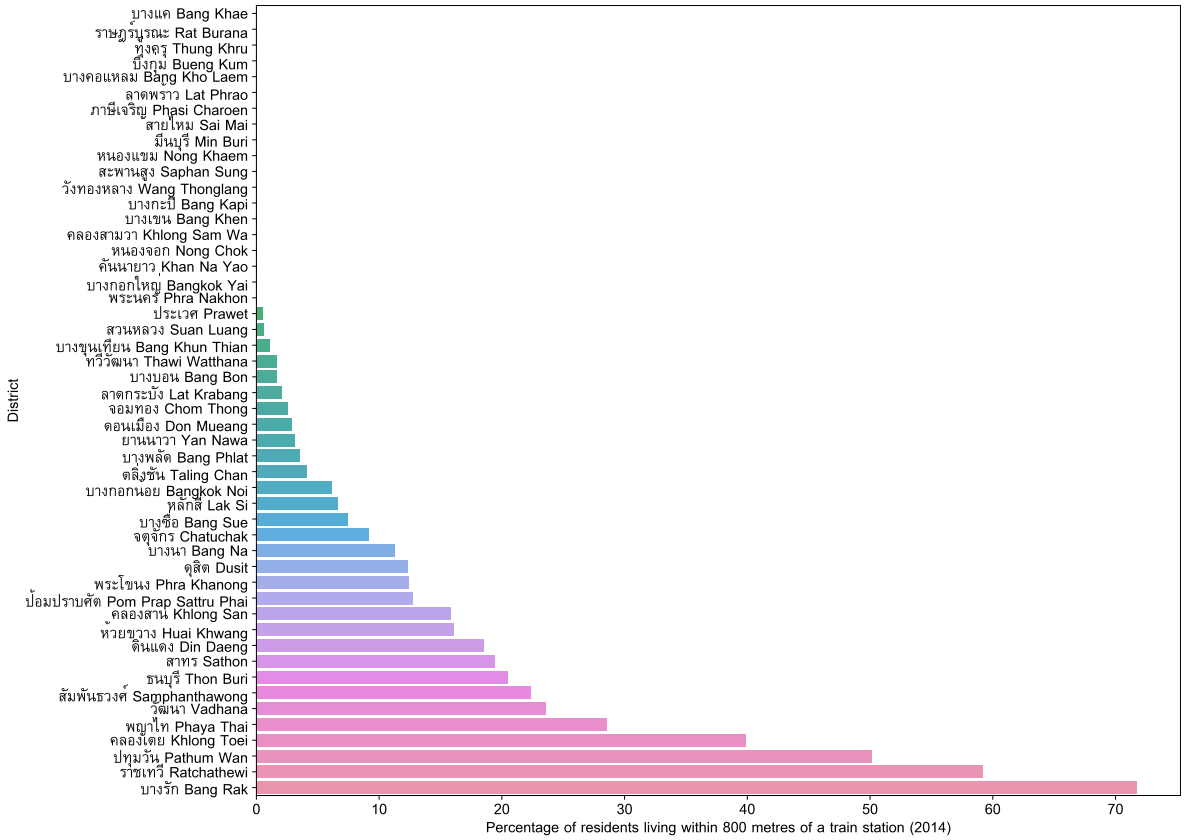


Fig. 189: Districts ranked in ascending order by % living within 800 metres with regard to percentage of residents living within 800 metres of a train station (2014).

2.4.5 Healthy population

ประชากรมีสุขภาพดี ทั้งทางกายและจิตใจ

Healthy population refers to the health status and health outcomes within the population.

Dataset: Public Transport

Ferry terminals / quays along the Chao Praya river and Canal Sansabai (BMA, 2014) were combined and analysed for Accessibility using an OSM pedestrian network, derived using OSMnx.

Data source: `BangkokGIS (BMA)`

Publication year: `2014`

Target year: `2014`

Acquisition date (yyyymmdd): `20181210`

Licence: `none specified`

Spatial reference (EPSG code): `32647.0`

Date type: `vector`

Scale / Resolution: `800`

Percentage of residents living within 800 metres of a ferry terminal or pier (2014)

Accessibility within 800m was evaluated using the Python network analysis package Pandana for a series of sample points generated every 50 metres along the Bangkok OSM pedestrian network. Population weighted averages for the proportion of sample points having access in each subdistrict were used to estimate the measure.

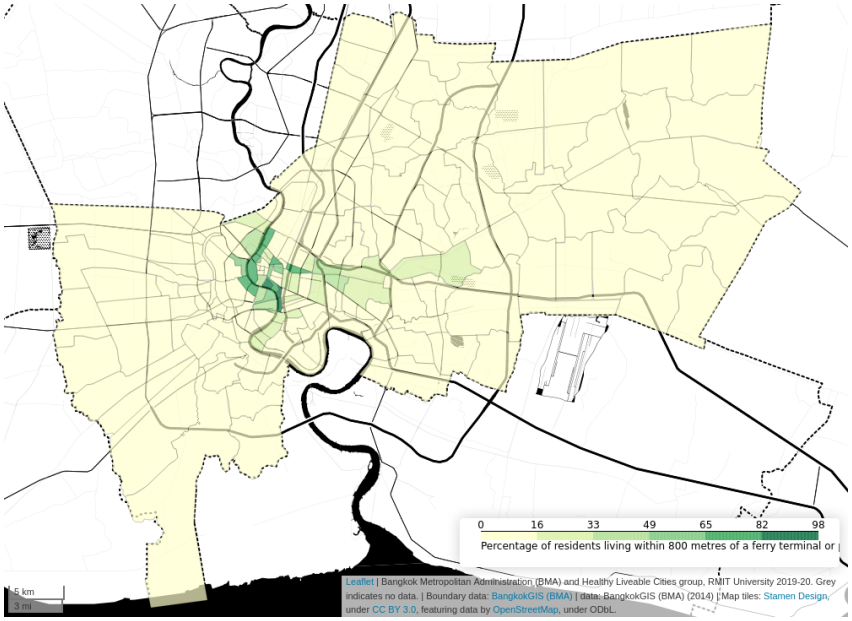


Fig. 190: Percentage of residents living within 800 metres of a ferry terminal or pier (2014), by subdistrict

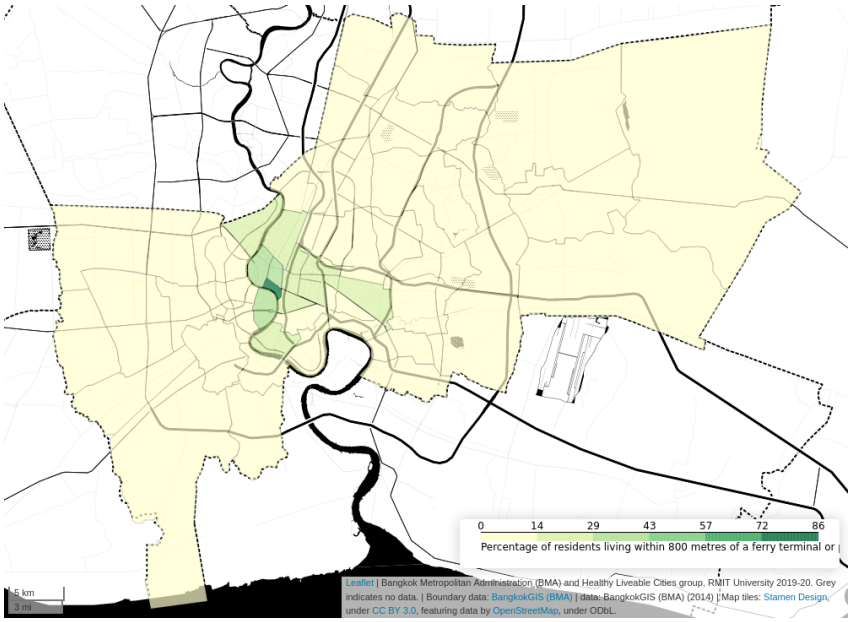


Fig. 191: Percentage of residents living within 800 metres of a ferry terminal or pier (2014), by district

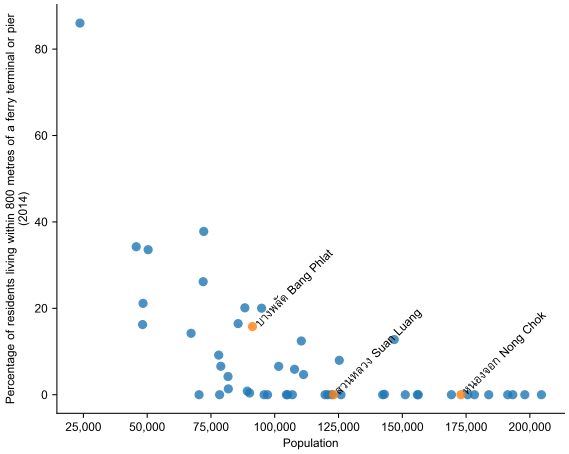


Fig. 192: Scatterplot of % living within 800 metres by population for districts.

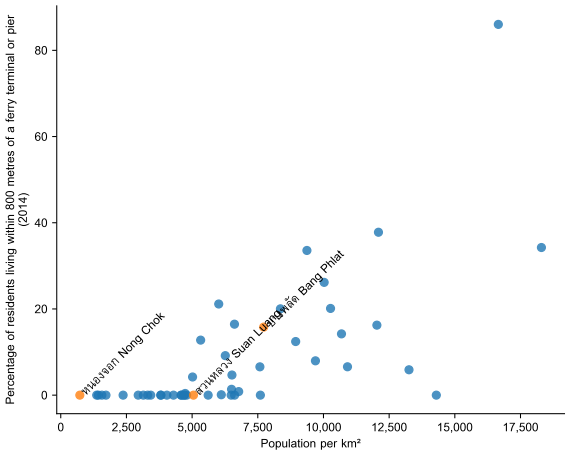


Fig. 193: Scatterplot of % living within 800 metres by population density for districts.

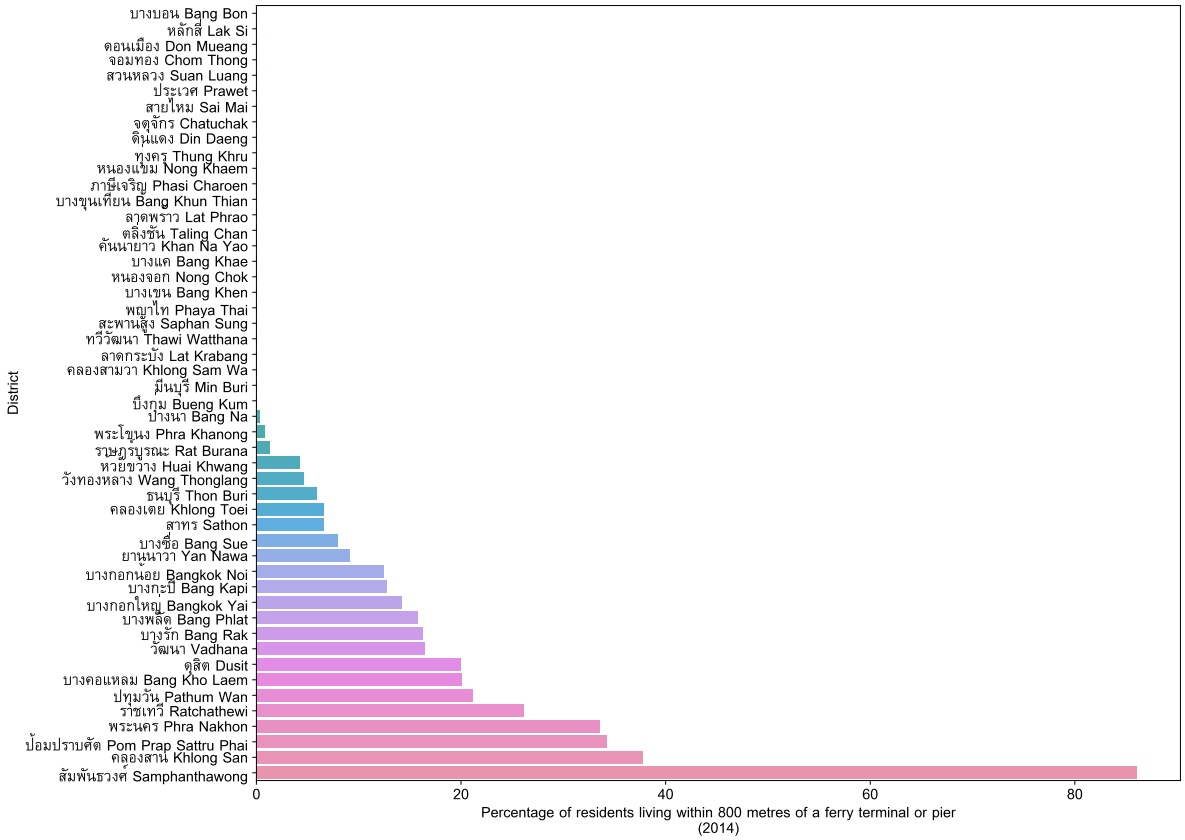


Fig. 194: Districts ranked in ascending order by % living within 800 metres with regard to percentage of residents living within 800 metres of a ferry terminal or pier (2014).

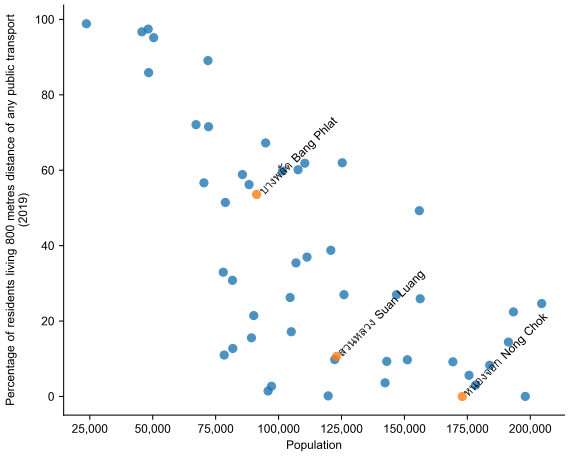


Fig. 195: Scatterplot of % living within 800 metres by population for districts.

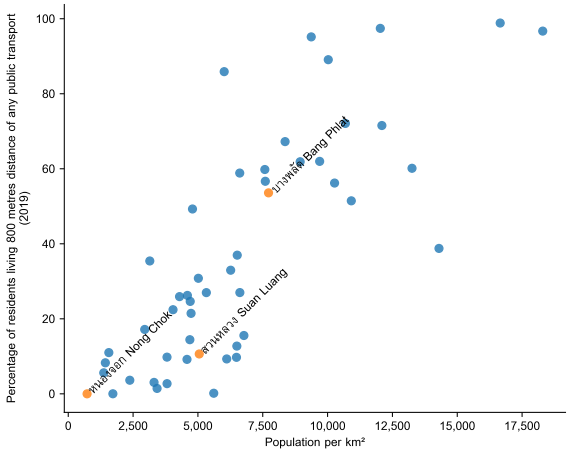


Fig. 196: Scatterplot of % living within 800 metres by population density for districts.

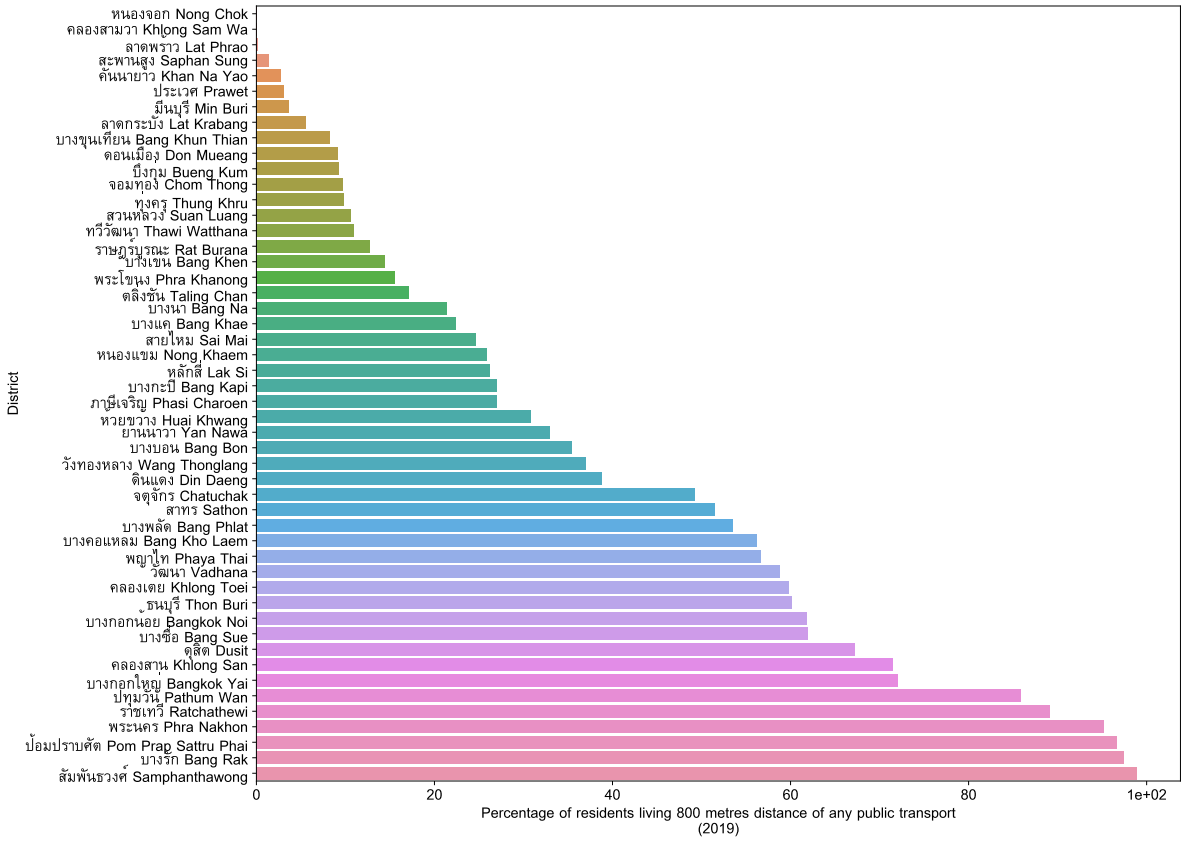


Fig. 197: Districts ranked in ascending order by % living within 800 metres with regard to percentage of residents living 800 metres distance of any public transport (2019).

2.5 Enhancing quality of life

2.5.1 Job security

ความมั่นคงในการทำงาน

Security at work or employment means the confidence of people that they will not lose their current job without sufficient or acceptable reason.

Dataset: Welfare card holders

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `BMA`

Publication year: `2017`

Target year: `2018`

Acquisition date (yyyymmdd): `20191204`

Licence: `none specified`

Licence URL: `Ministry of Finance; Department of Social Development (BMA)`

Date type: `integer`

Scale / Resolution: `area summary`

Notes: `Only two districts have 12 locations; perhaps <= 10 would be a more aspirational target.`

Data location relative to project folder: `./data/Thai/_from BMA/20191204/transfer_1815197_files_51cc5a2c/1_Holders of a state welfare card in Bangkok by district_kn20191111.xlsx`

Holders of a state welfare card in Bangkok (2017)

The count of persons issued a state welfare card in Bangkok Year 2017 was recorded for each district.

Aligns with Sustainable Development Goals: 3, 11, 13, 15.

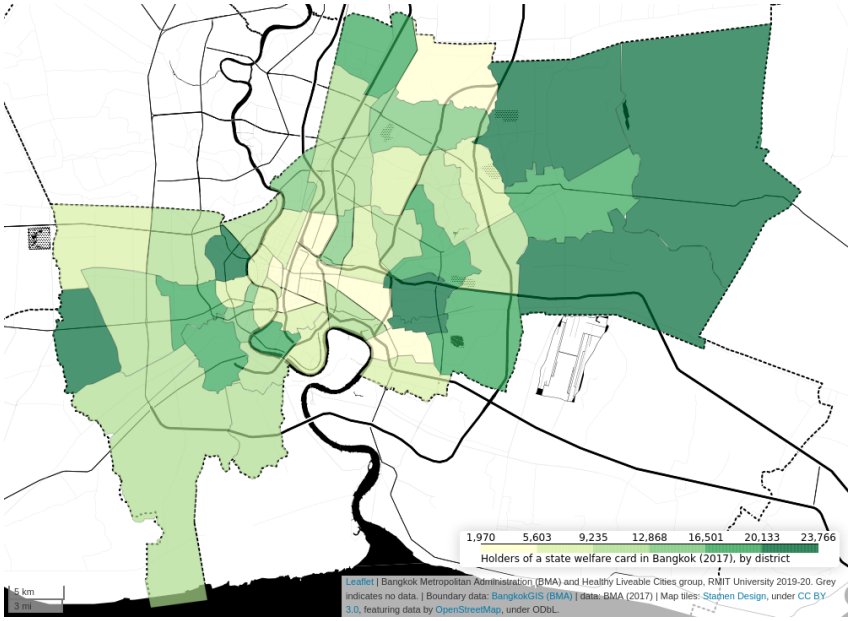


Fig. 198: Holders of a state welfare card in Bangkok (2017), by district

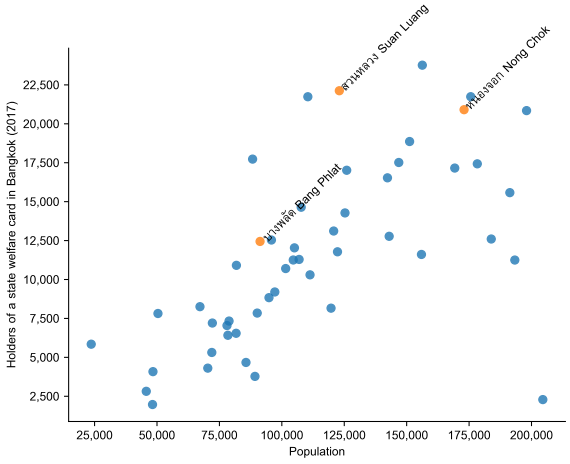


Fig. 199: Scatterplot of State welfare card holders by population for districts.

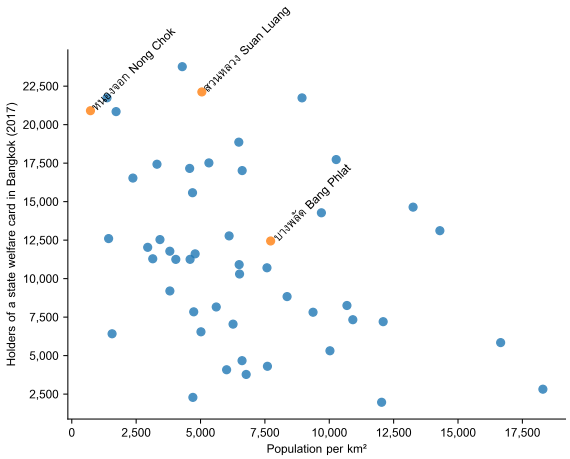


Fig. 200: Scatterplot of State welfare card holders by population density for districts.

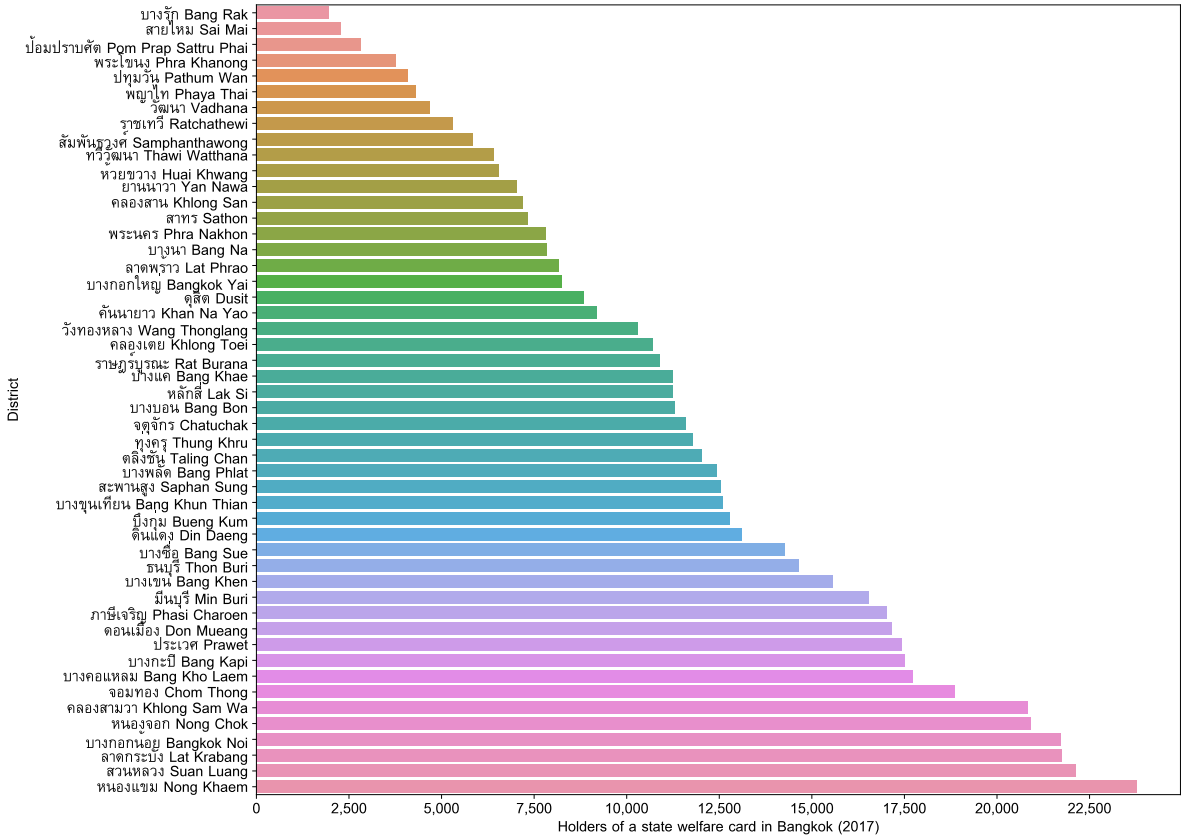


Fig. 201: Districts ranked in ascending order by state welfare card holders with regard to holders of a state welfare card in bangkok (2017).

Dataset: Drought impact

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `BMA`

Publication year: `2015`

Target year: `2016`

Acquisition date (yyyymmdd): `20191204`

Licence: `none specified`

Licence URL: `Ministry of Finance; Department of Social Development (BMA)`

Date type: `integer`

Scale / Resolution: `area summary`

Notes: `Only two districts have 12 locations; perhaps <= 10 would be a more aspirational target.`

Data location relative to project folder: `./data/Thai/_from BMA/20191204/transfer_1815197_files_51cc5a2c/2_BKK agriculture _drought_2016 _ district _kn20191124.xlsx`

Number of registered farmer households expected to be impacted by drought (2016)

Number of farmers (households) who expected to be impacted drought in 2016 was recorded for each district.

Aligns with Sustainable Development Goals: 3, 11, 13, 15.

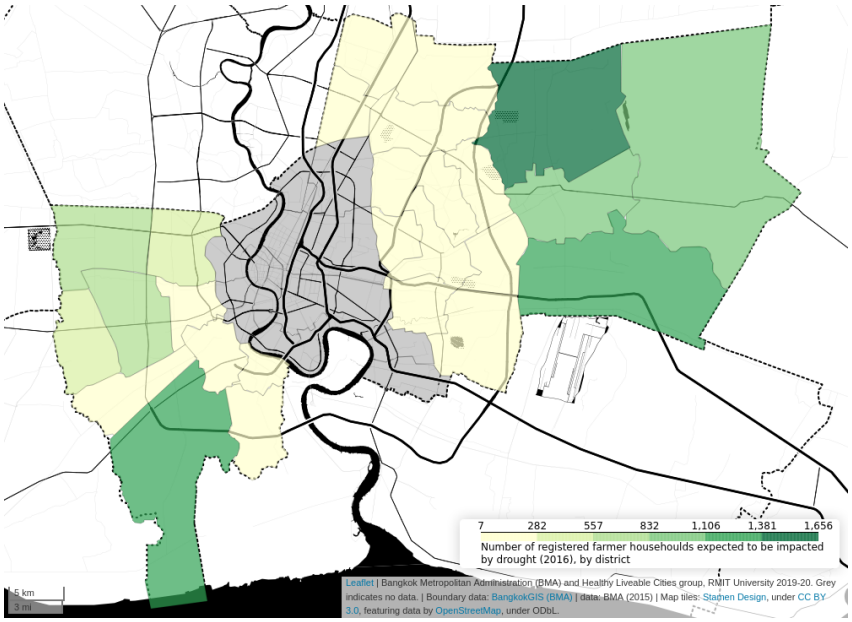


Fig. 202: Number of registered farmer households expected to be impacted by drought (2016), by district

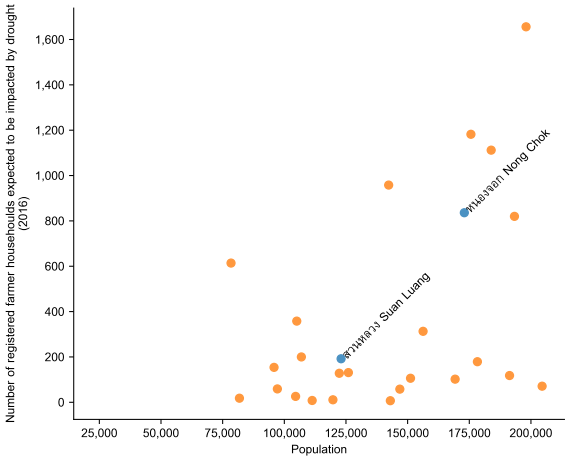


Fig. 203: Scatterplot of Number of households in the area expected to get impacts drought (registered farmers) by population for districts.

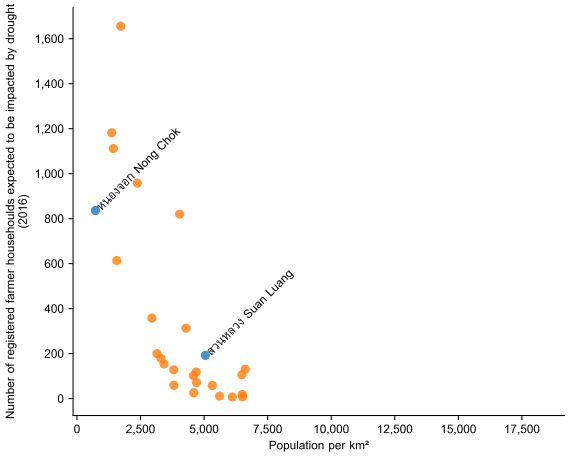


Fig. 204: Scatterplot of Number of households in the area expected to get impacts drought (registered farmers) by population density for districts.

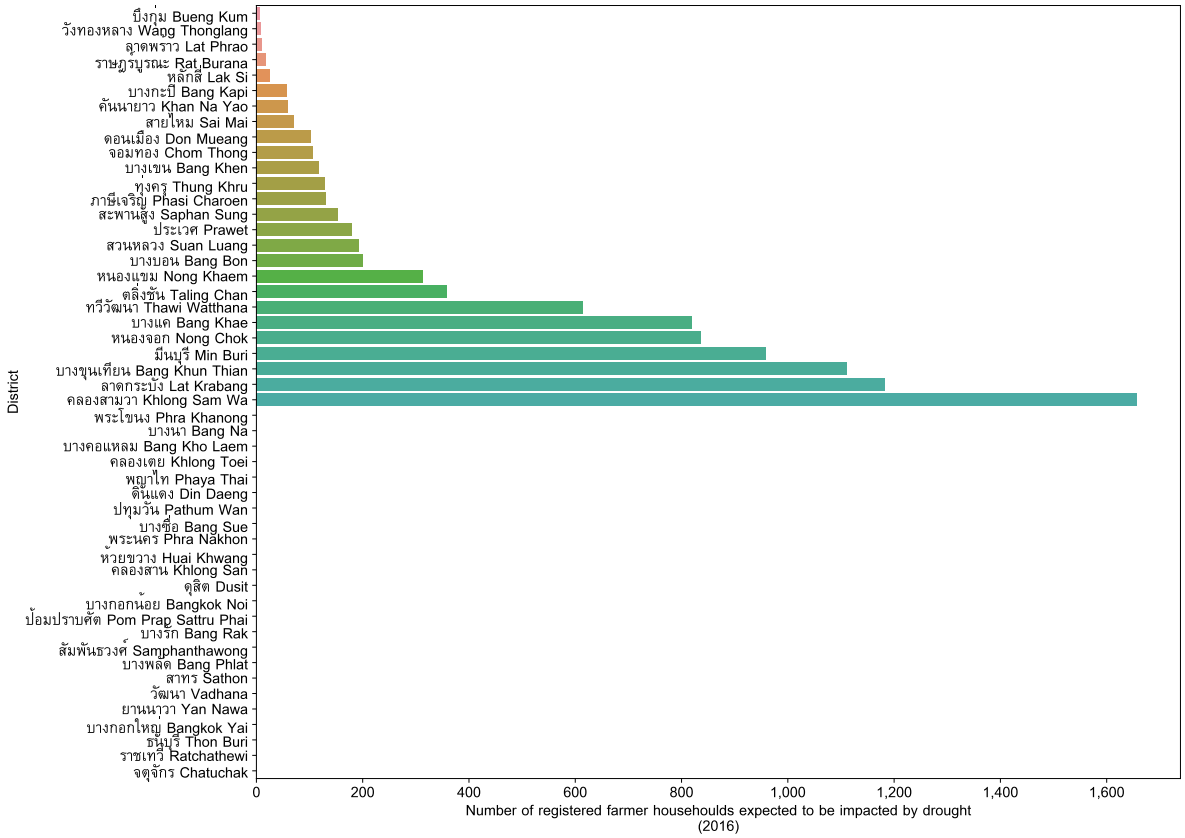


Fig. 205: Districts ranked in ascending order by number of households in the area expected to get impacts drought (registered farmers) with regard to number of registered farmer households expected to be impacted by drought (2016).

2.5.2 Healthy population

ประชากรมีสุขภาพดี ทั้งทางกายและจิตใจ

Healthy population refers to the health status and health outcomes within the population.

Dataset: Population by age groups

Bangkok population counts classified by years of age (December 2018) were cleaned for processing, aligned with standard area identification codes, and used to derive average and standard deviation for age for each district and subdistrict.

Data source: `Department of Provincial Administration, Ministry of Interior (BMA)`

Publication year: `2018`

Target year: `2018`

Acquisition date (yyyymmdd): `20190930`

Licence: `none specified`

Date type: `numeric`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190930/transfer_1730651_files_296a713c/Bangkok Population by age groups2018_kn08242019.xlsx`

Average age (2018)

The average age of residents for each district and subdistrict was estimated and recorded.

Aligns with Sustainable Development Goals: 3, 11.

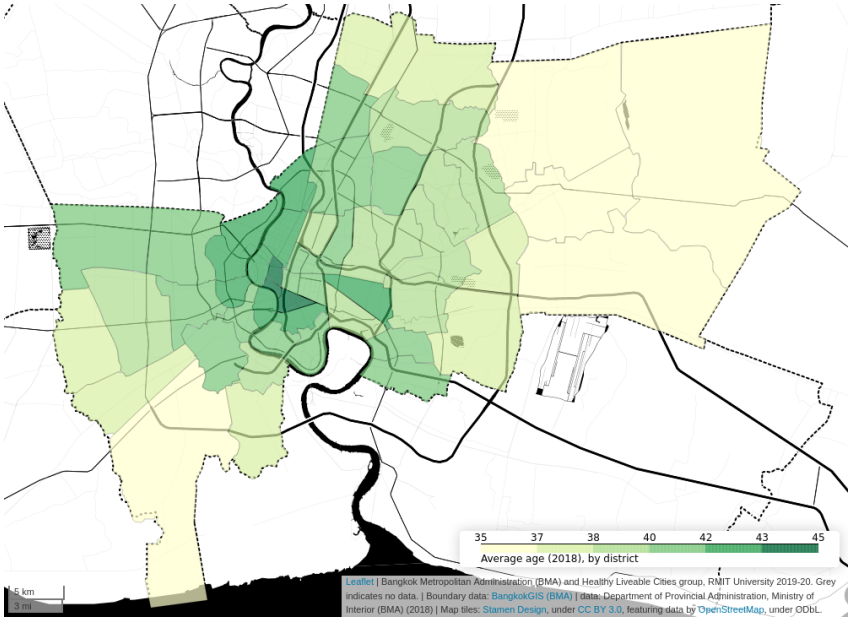


Fig. 206: Average age (2018), by district

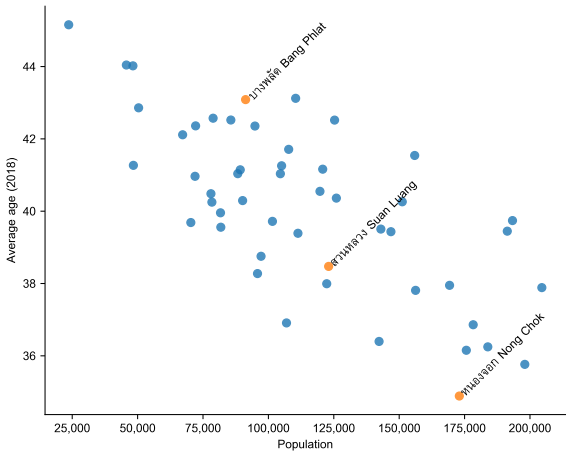


Fig. 207: Scatterplot of average age by population for districts.

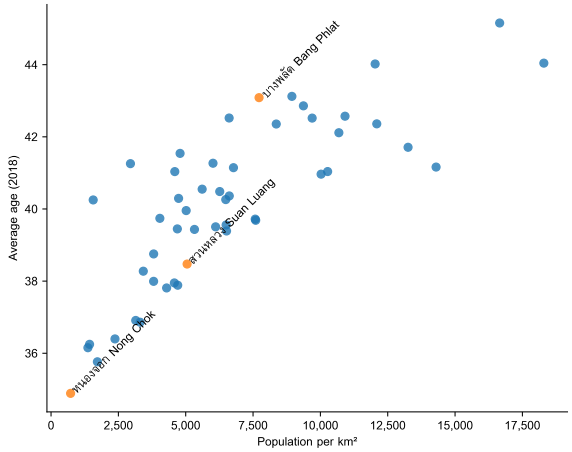


Fig. 208: Scatterplot of average age by population density for districts.

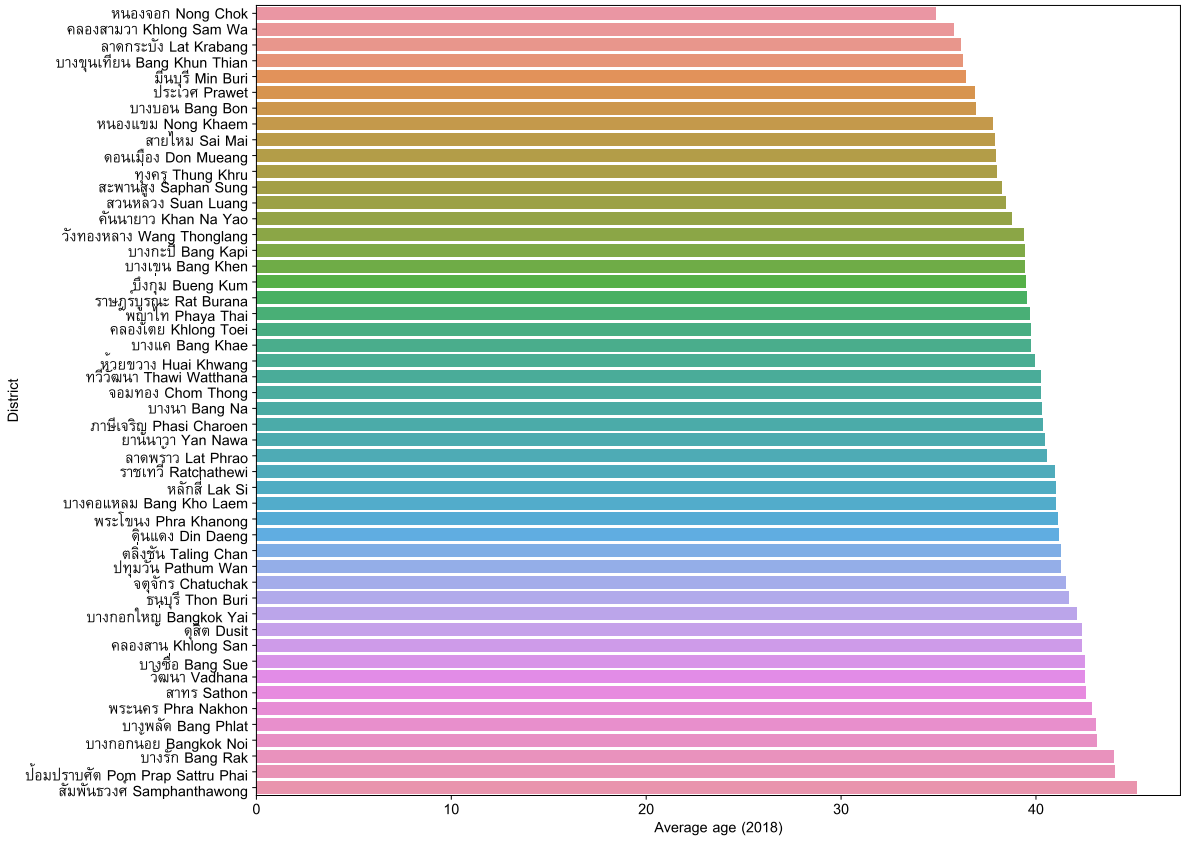


Fig. 209: Districts ranked in ascending order by average age with regard to average age (2018).

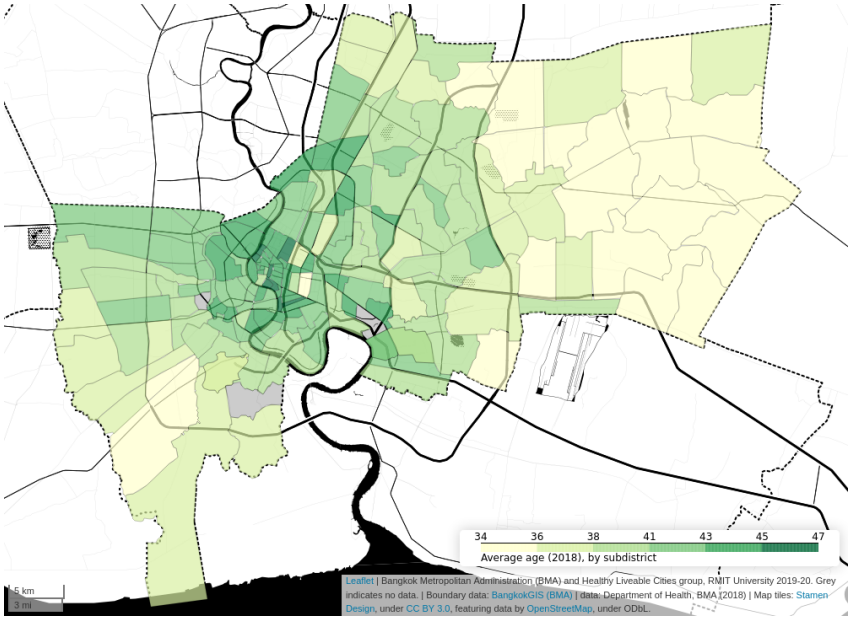


Fig. 210: Average age (2018), by subdistrict

Dataset: Vital diseases

Data at subdistrict level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `Department of Health, BMA`

Publication year: `2018`

Target year: `2018`

Acquisition date (yyyymmdd): `20190617`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190617/vital diseases HC BMA 2018.xlsx`

Health centers (2018)

The count of health centers within each analysis area was calculated, based on the supplied data.

Aligns with Sustainable Development Goals: 3, 11.

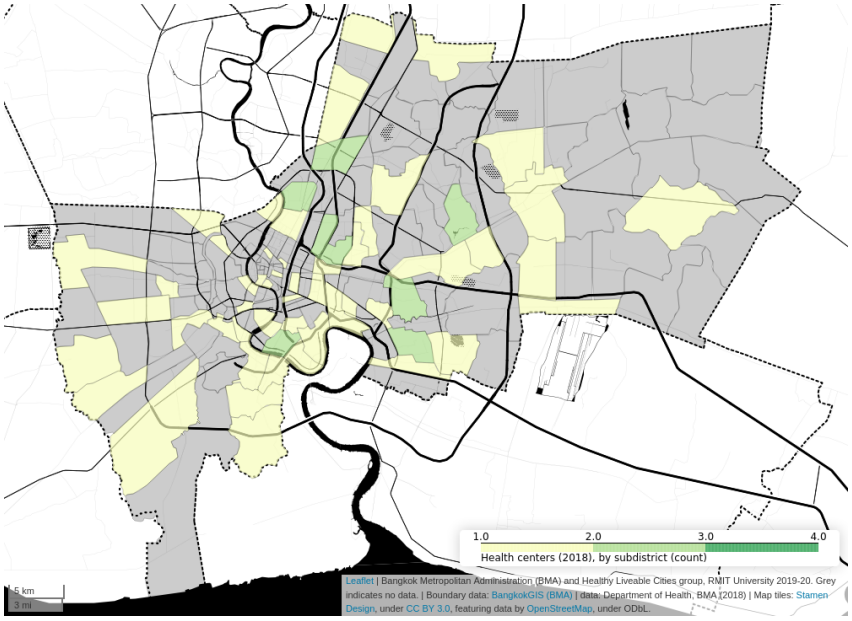


Fig. 211: Health centers (2018), by subdistrict

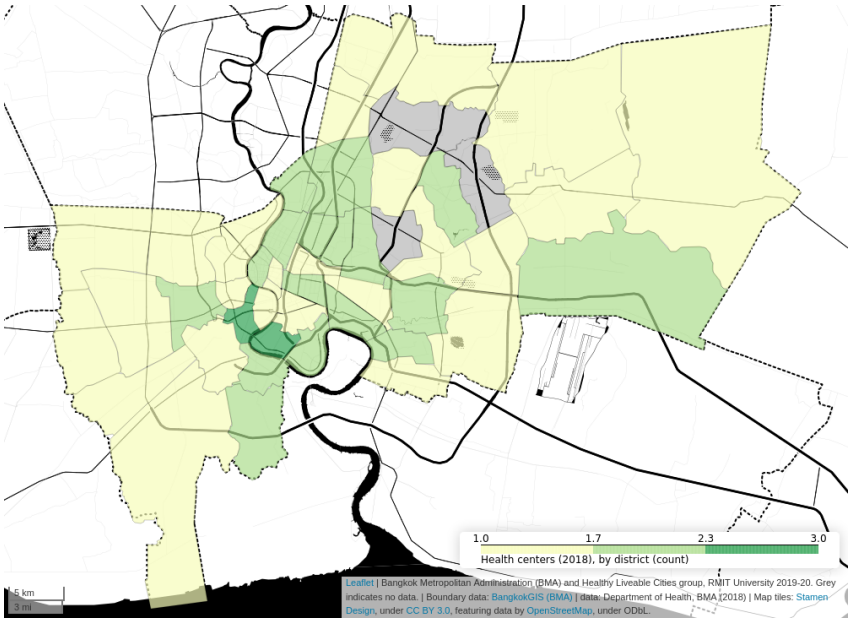


Fig. 212: Health centers (2018), by district

Health centers (2018) per km²

The count of health centers within each analysis area was calculated, based on the supplied data. The indicator was rated as the rate per km².

Aligns with Sustainable Development Goals: 3, 11.

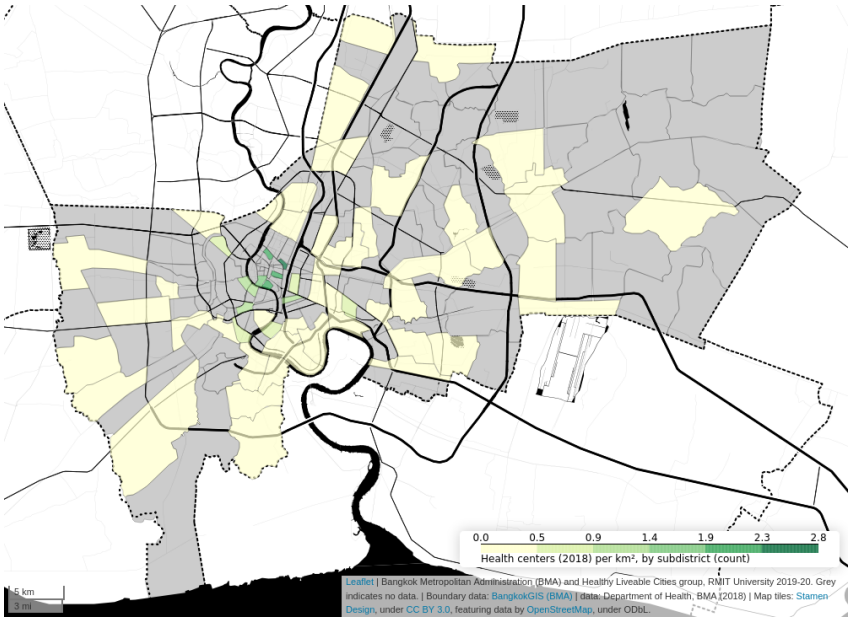


Fig. 213: Health centers (2018) per km², by subdistrict

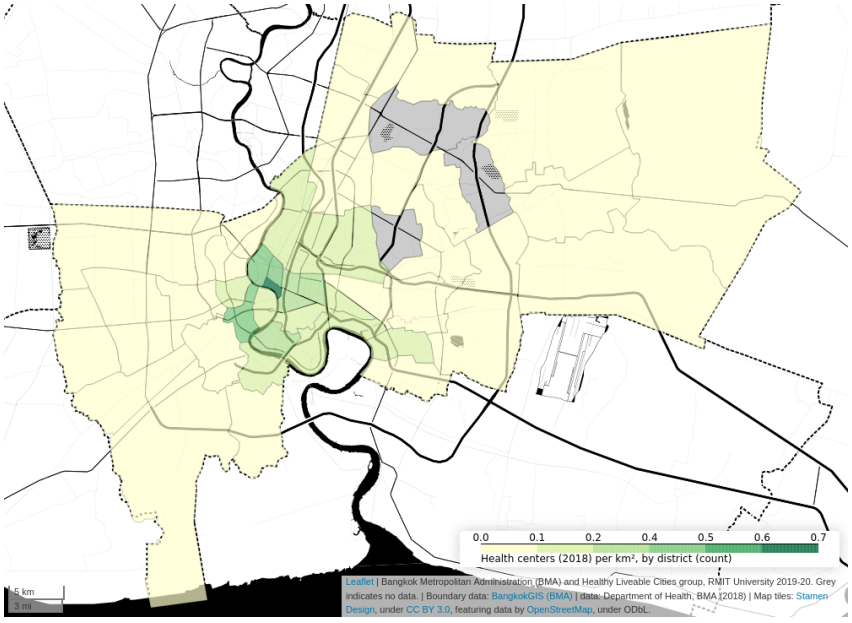


Fig. 214: Health centers (2018) per km², by district

Health centers (2018) per 10,000 population

The count of health centers within each analysis area was calculated, based on the supplied data. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 3, 11.

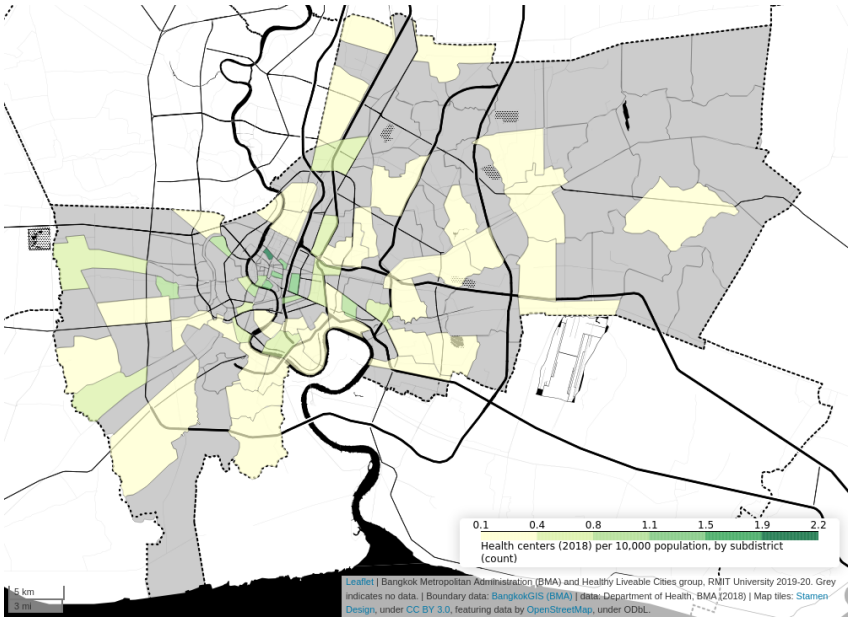


Fig. 215: Health centers (2018) per 10,000 population, by subdistrict

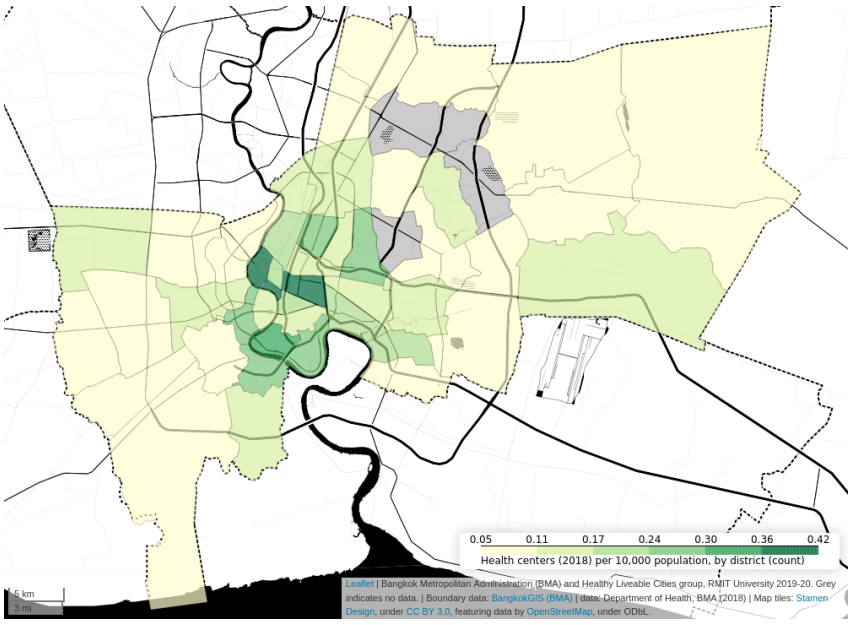


Fig. 216: Health centers (2018) per 10,000 population, by district

Health centers (2018) per 10,000 household

The count of health centers within each analysis area was calculated, based on the supplied data. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 3, 11.

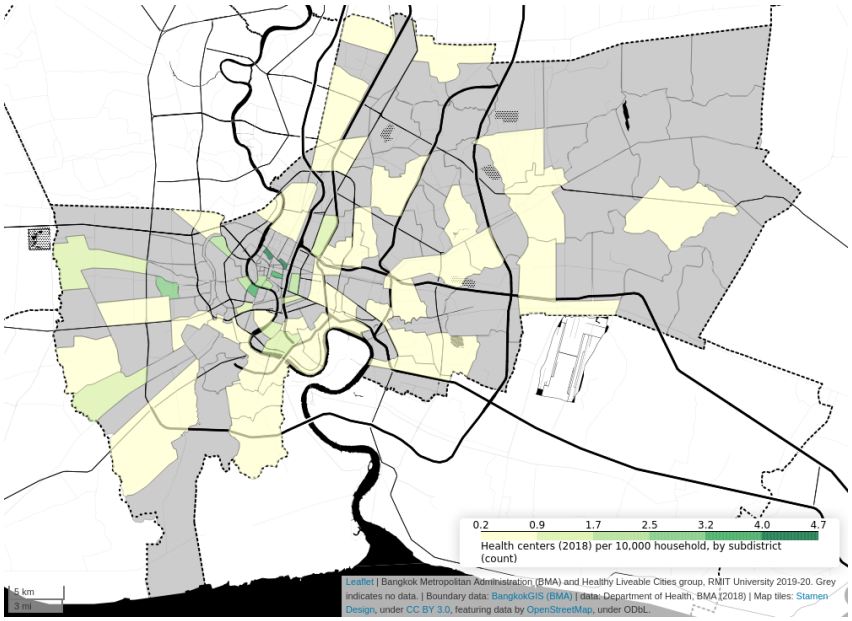


Fig. 217: Health centers (2018) per 10,000 household, by subdistrict

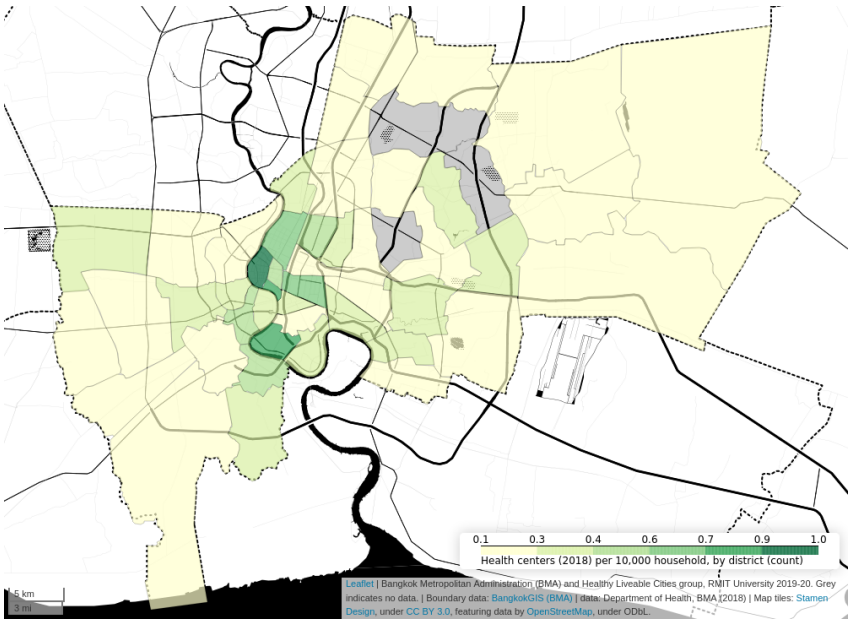


Fig. 218: Health centers (2018) per 10,000 household, by district

Mental and behavioural disorder outpatients (2018)

Outpatient numbers for mental and behavioural disorders were summed across each analysis area.

Aligns with Sustainable Development Goals: 3, 11.

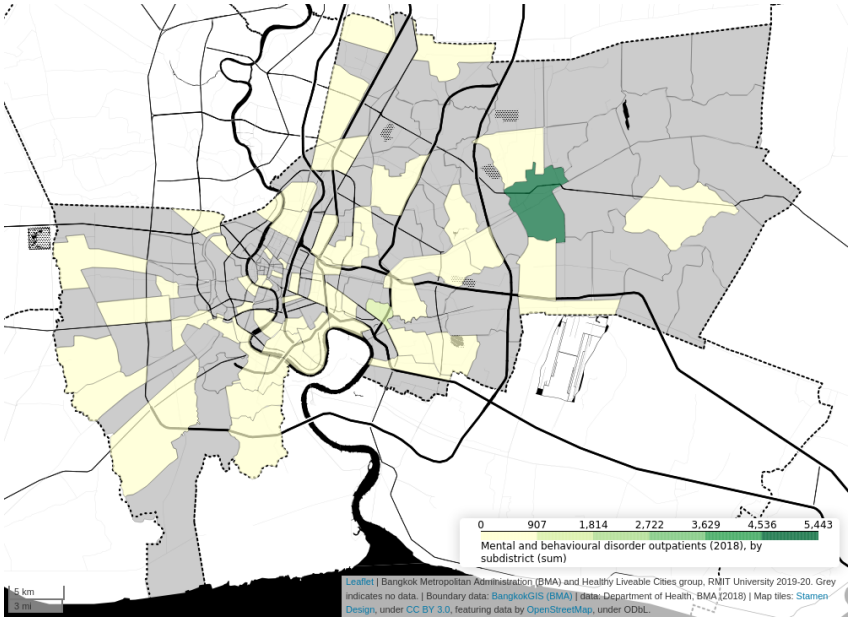


Fig. 219: Mental and behavioural disorder outpatients (2018), by subdistrict

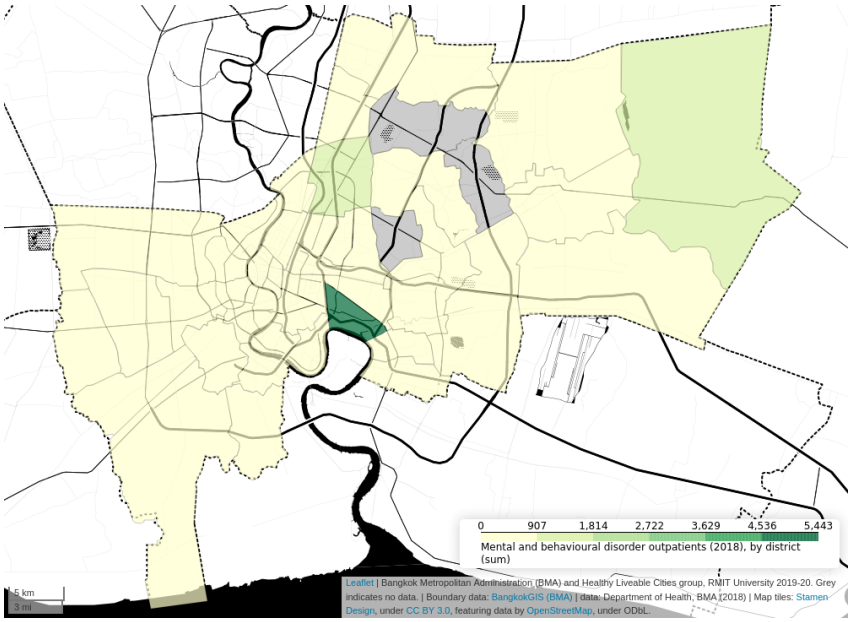


Fig. 220: Mental and behavioural disorder outpatients (2018), by district

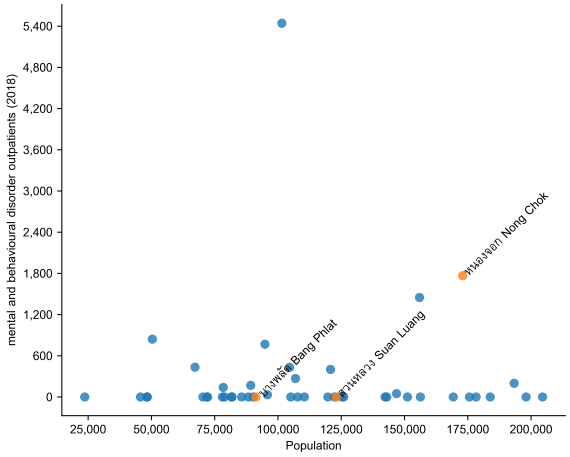


Fig. 221: Scatterplot of mental and behavioural disorders (2018) by population for districts.

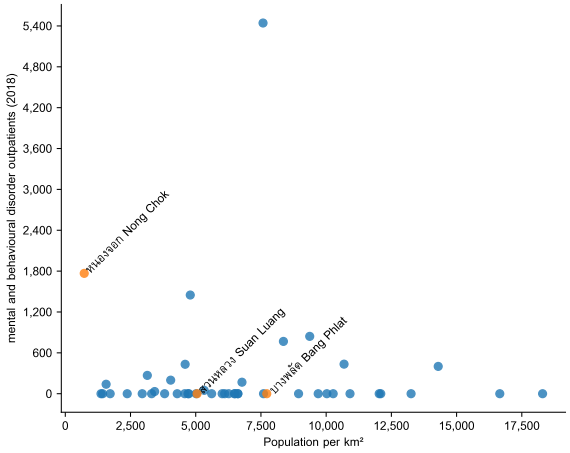


Fig. 222: Scatterplot of mental and behavioural disorders (2018) by population density for districts.

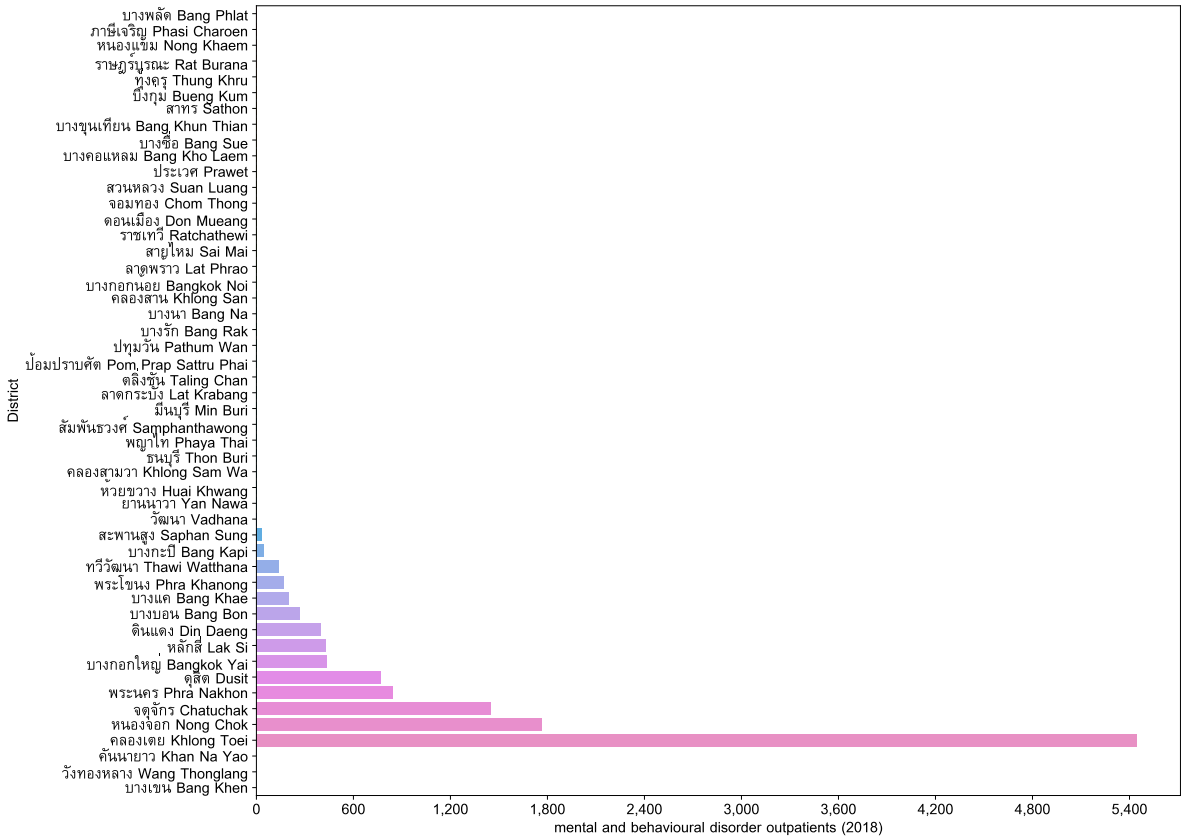


Fig. 223: Districts ranked in ascending order by mental and behavioural disorders (2018) with regard to mental and behavioural disorder outpatients (2018).

Mental and behavioural disorder outpatients (2018) per km²

Outpatient numbers for mental and behavioural disorders were summed across each analysis area. The indicator was rated as the rate per km².

Aligns with Sustainable Development Goals: 3, 11.

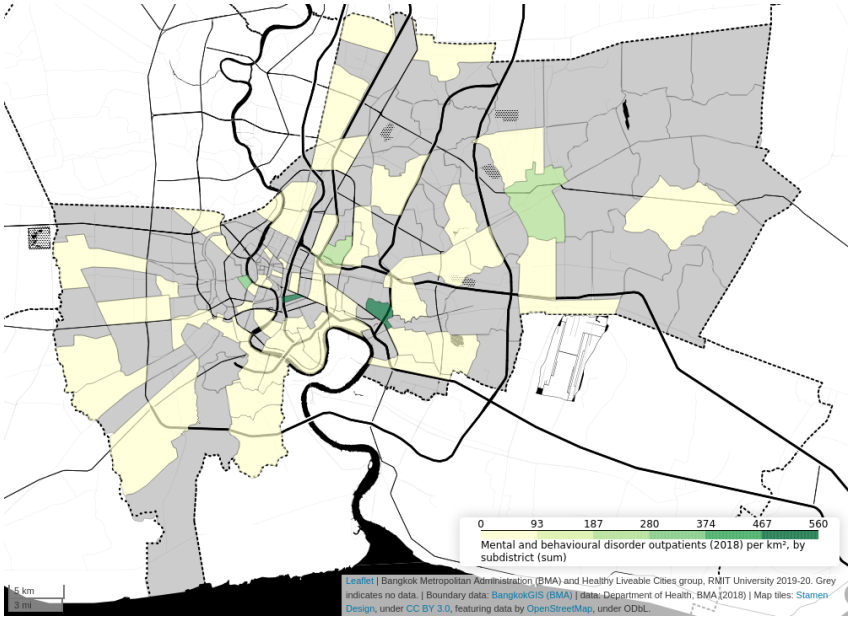


Fig. 224: Mental and behavioural disorder outpatients (2018) per km^2, by subdistrict

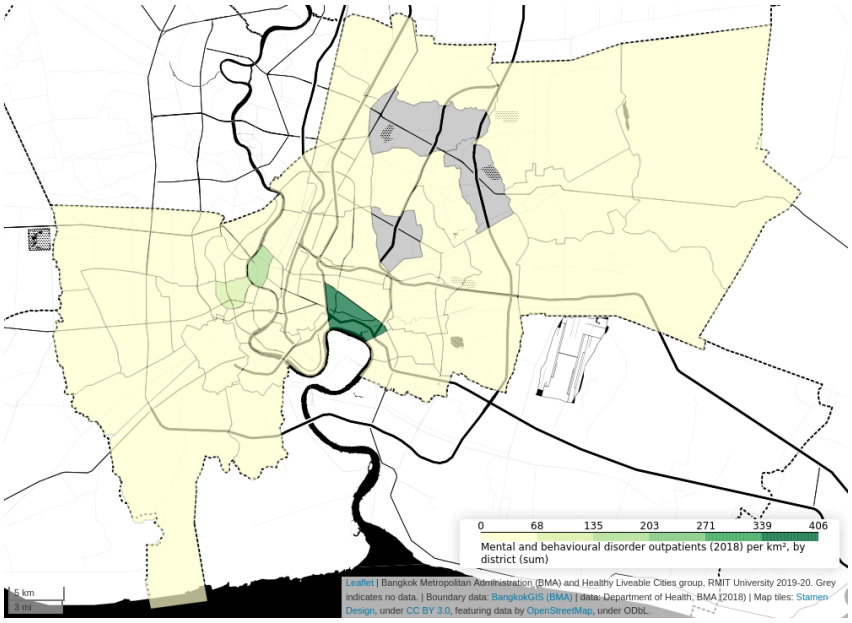


Fig. 225: Mental and behavioural disorder outpatients (2018) per km^2, by district

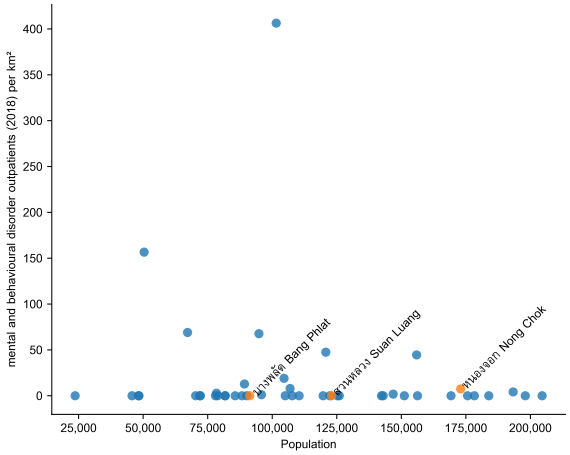


Fig. 226: Scatterplot of mental and behavioural disorders (2018) by population for districts.

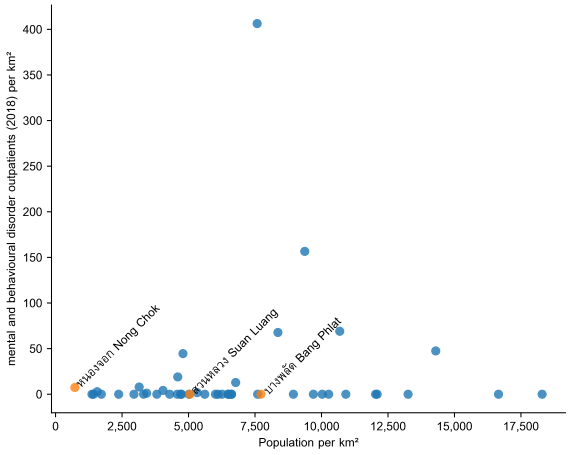


Fig. 227: Scatterplot of mental and behavioural disorders (2018) by population density for districts.

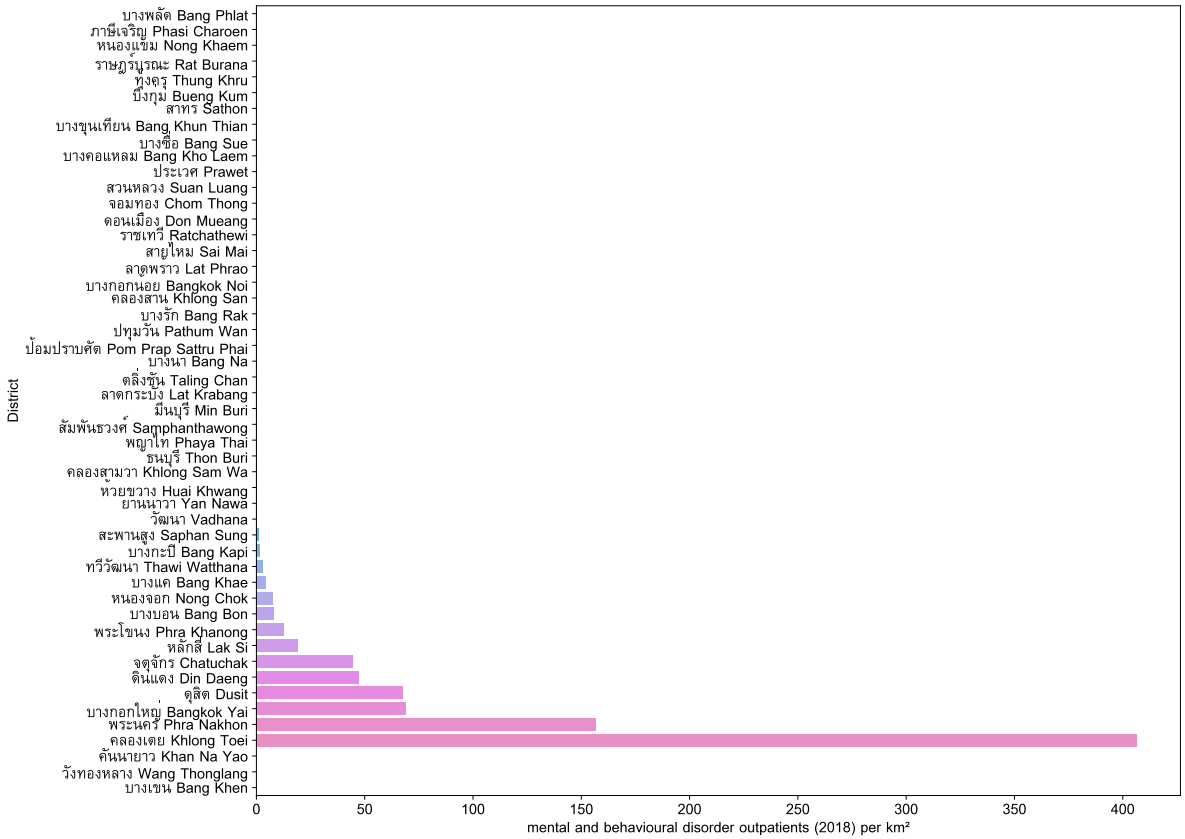


Fig. 228: Districts ranked in ascending order by mental and behavioural disorders (2018) with regard to mental and behavioural disorder outpatients (2018) per km^2.

Mental and behavioural disorder outpatients (2018) per 10,000 population

Outpatient numbers for mental and behavioural disorders were summed across each analysis area. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 3, 11.

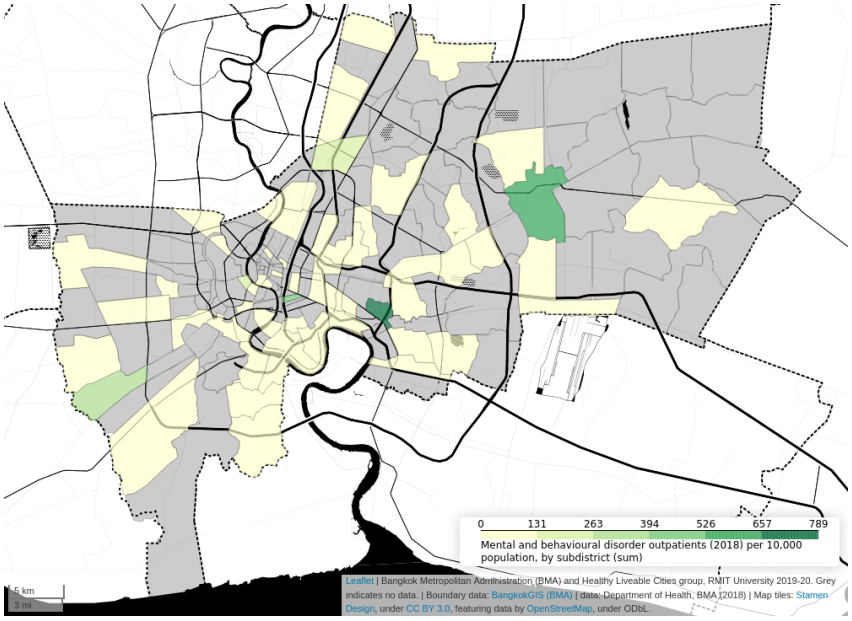


Fig. 229: Mental and behavioural disorder outpatients (2018) per 10,000 population, by subdistrict

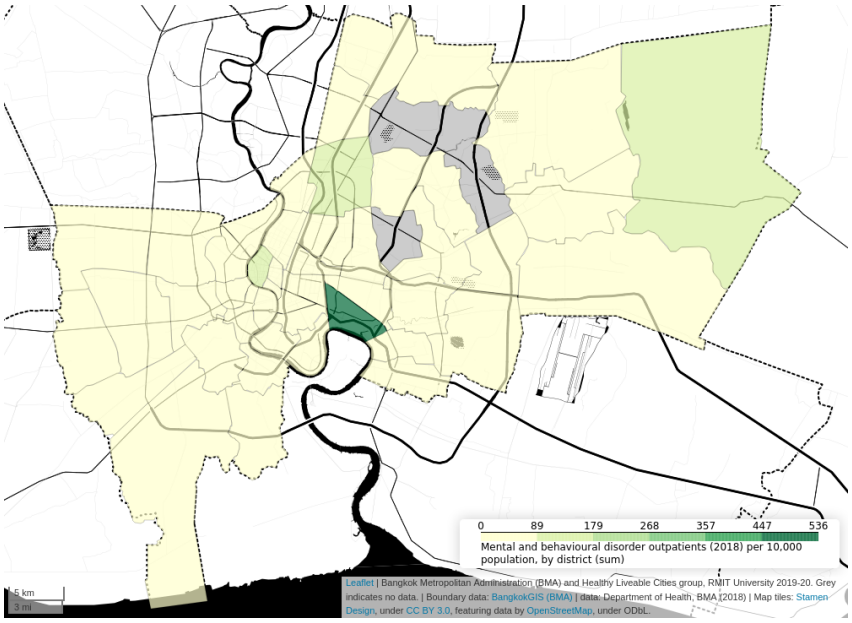


Fig. 230: Mental and behavioural disorder outpatients (2018) per 10,000 population, by district

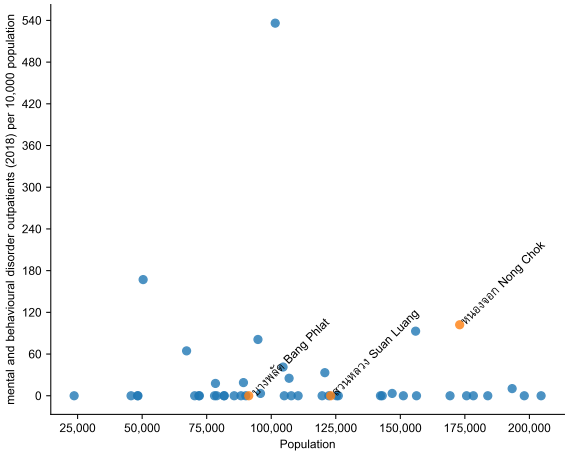


Fig. 231: Scatterplot of mental and behavioural disorders (2018) by population for districts.

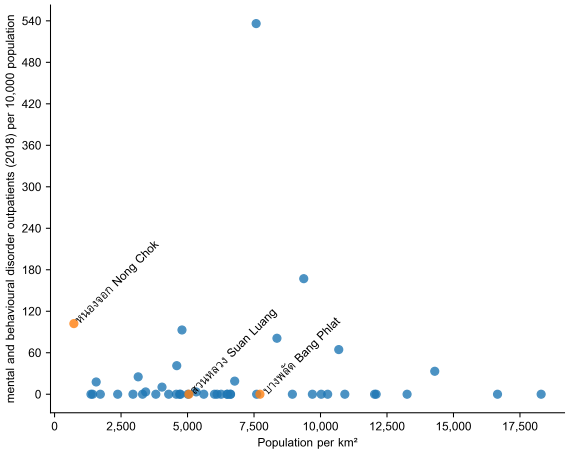


Fig. 232: Scatterplot of mental and behavioural disorders (2018) by population density for districts.

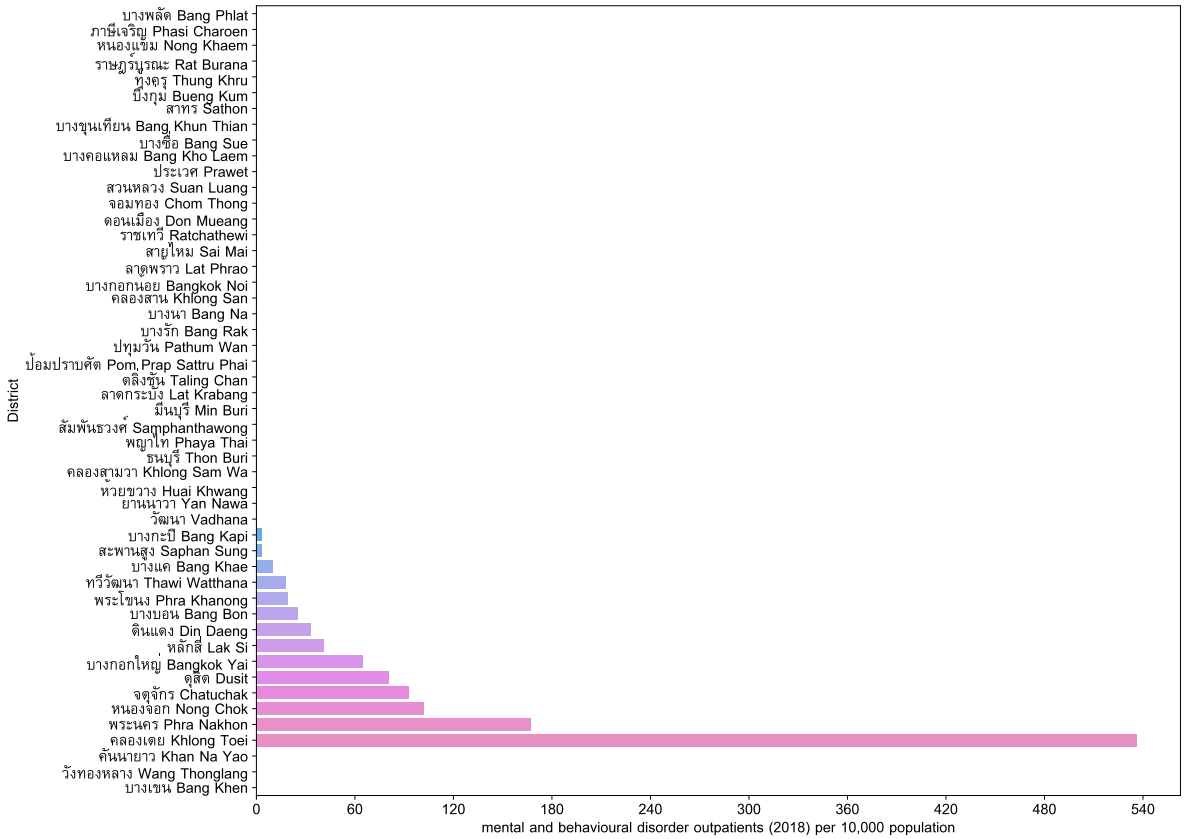


Fig. 233: Districts ranked in ascending order by mental and behavioural disorders (2018) with regard to mental and behavioural disorder outpatients (2018) per 10,000 population.

Mental and behavioural disorder outpatients (2018) per 10,000 household

Outpatient numbers for mental and behavioural disorders were summed across each analysis area. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 3, 11.

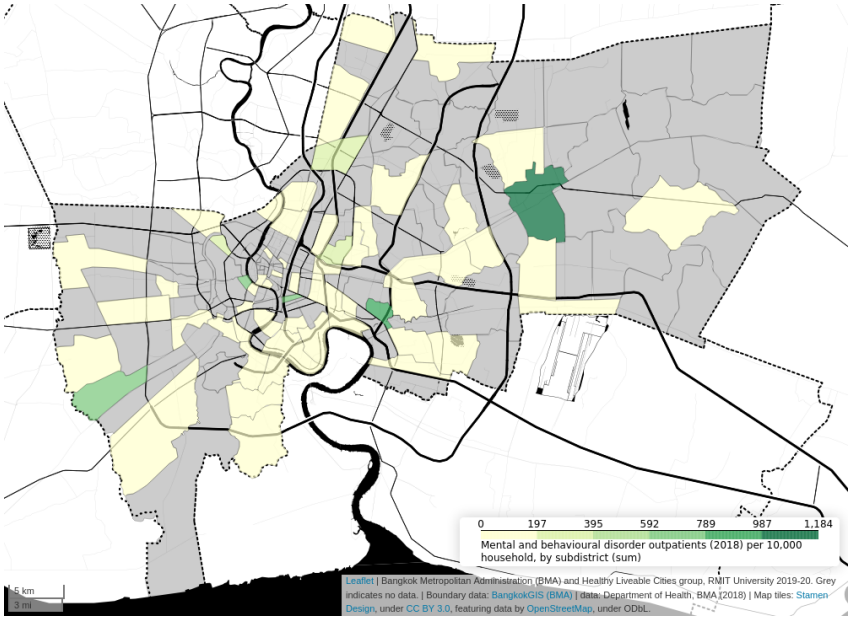


Fig. 234: Mental and behavioural disorder outpatients (2018) per 10,000 household, by subdistrict

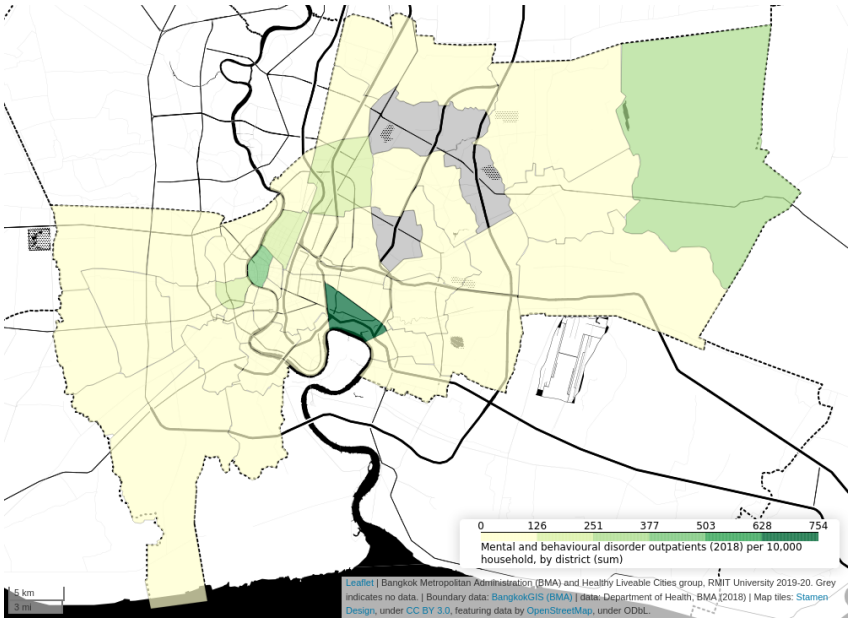


Fig. 235: Mental and behavioural disorder outpatients (2018) per 10,000 household, by district

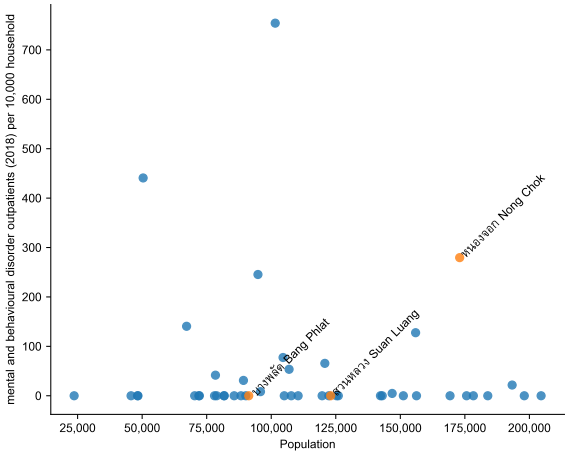


Fig. 236: Scatterplot of mental and behavioural disorders (2018) by population for districts.

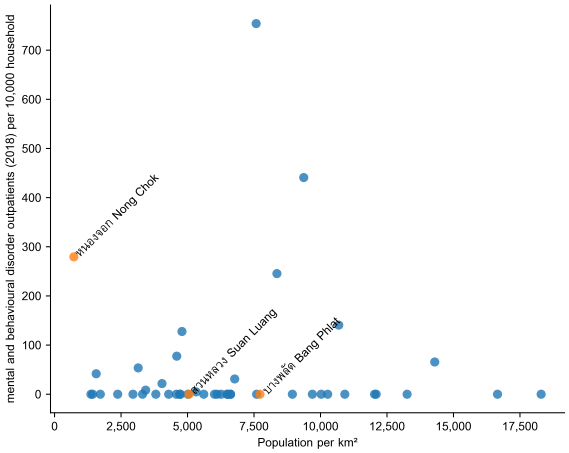


Fig. 237: Scatterplot of mental and behavioural disorders (2018) by population density for districts.

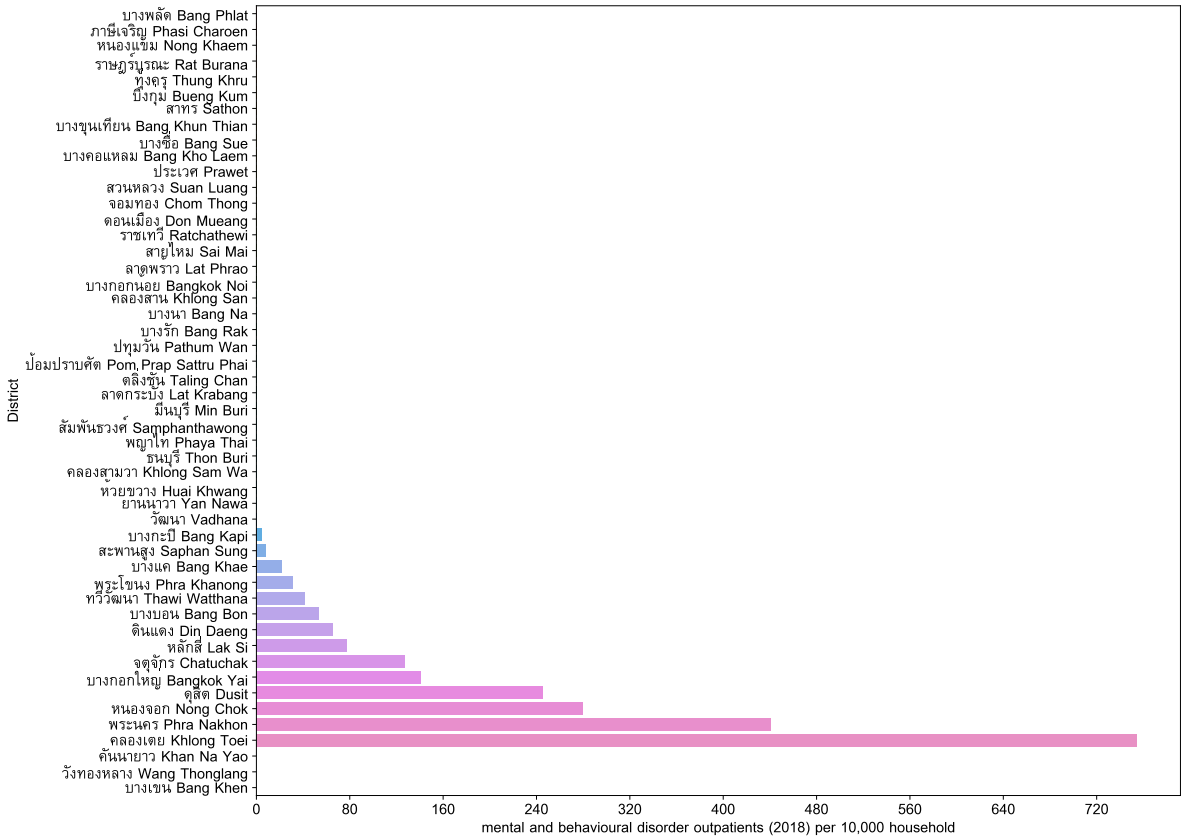


Fig. 238: Districts ranked in ascending order by mental and behavioural disorders (2018) with regard to mental and behavioural disorder outpatients (2018) per 10,000 household.

Hypertension outpatients (2018)

Outpatient numbers for hypertension were summed across each analysis area.

Aligns with Sustainable Development Goals: 3, 11.

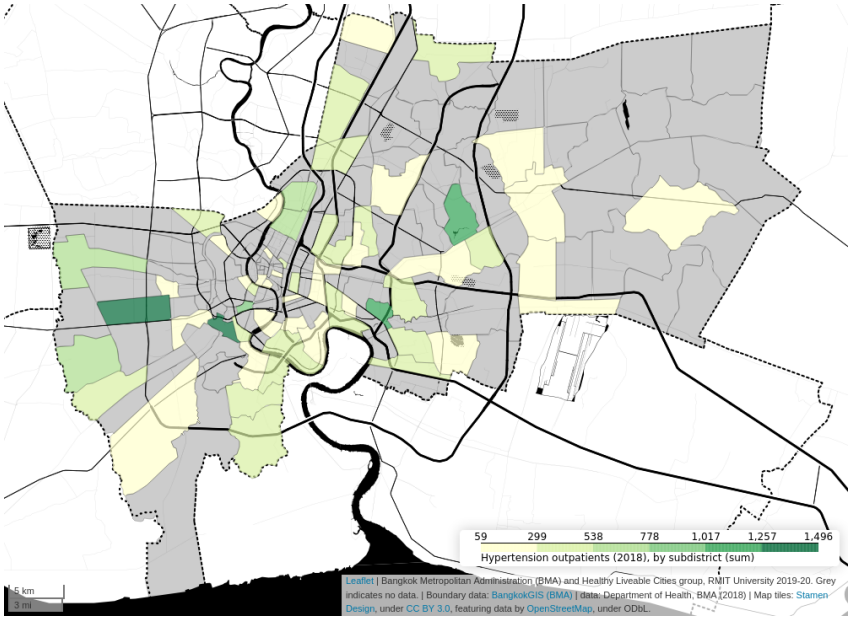


Fig. 239: Hypertension outpatients (2018), by subdistrict

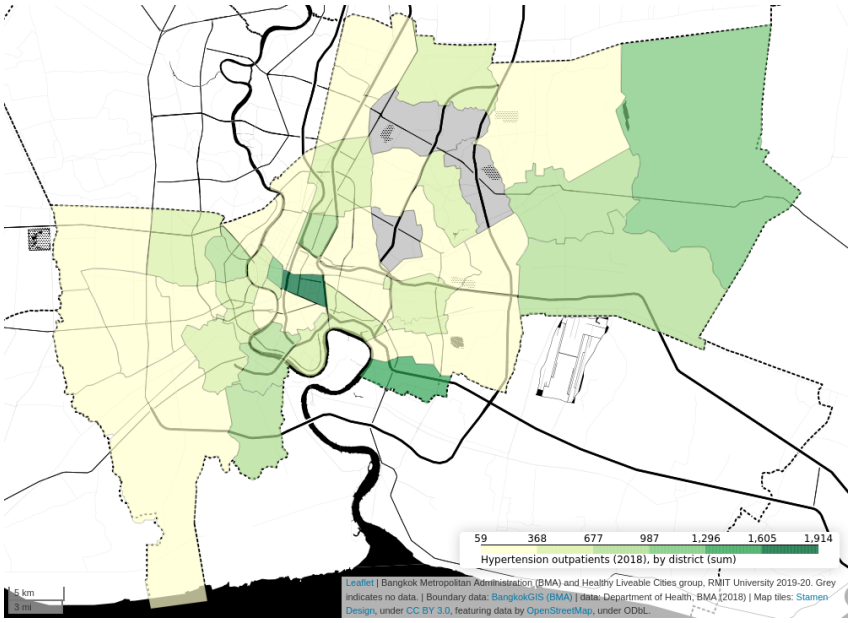


Fig. 240: Hypertension outpatients (2018), by district

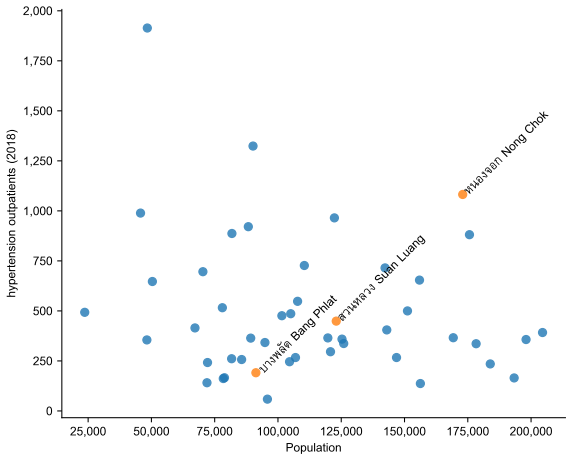


Fig. 241: Scatterplot of hypertension (2018) by population for districts.

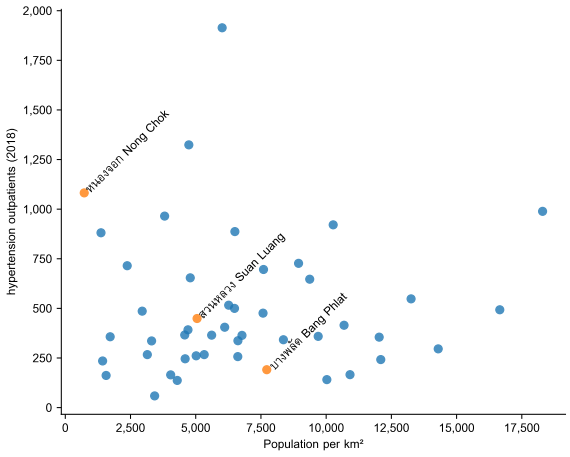


Fig. 242: Scatterplot of hypertension (2018) by population density for districts.

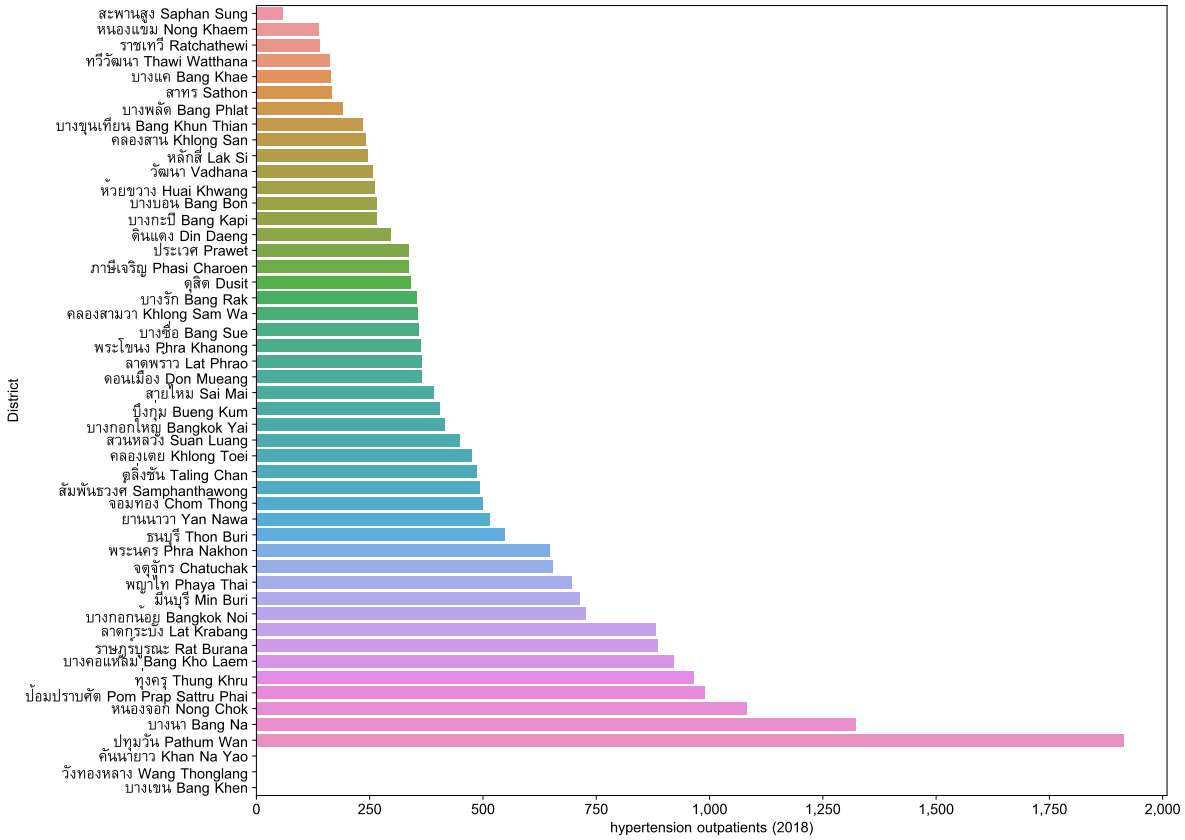


Fig. 243: Districts ranked in ascending order by hypertension (2018) with regard to hypertension outpatients (2018).

Hypertension outpatients (2018) per km²

Outpatient numbers for hypertension were summed across each analysis area. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 3, 11.

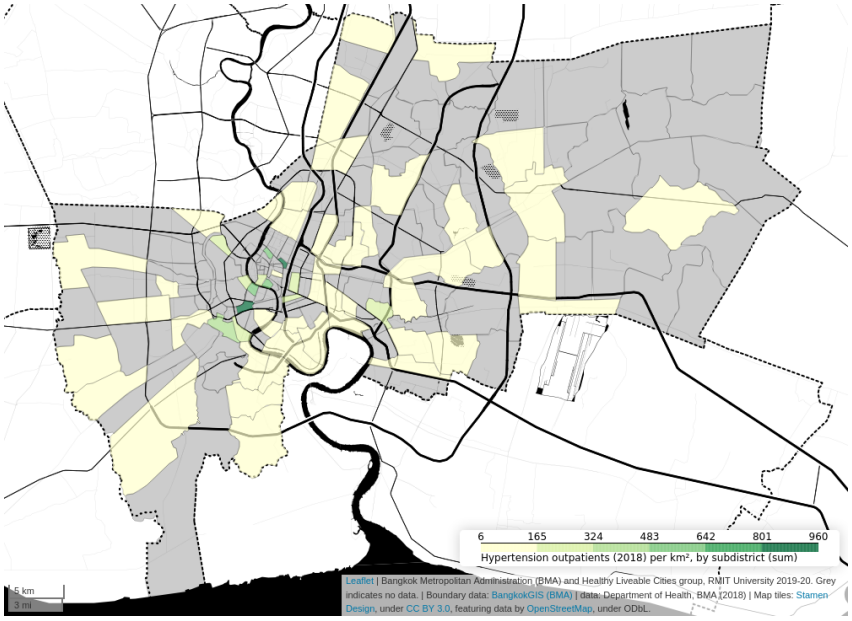


Fig. 244: Hypertension outpatients (2018) per km^2, by subdistrict

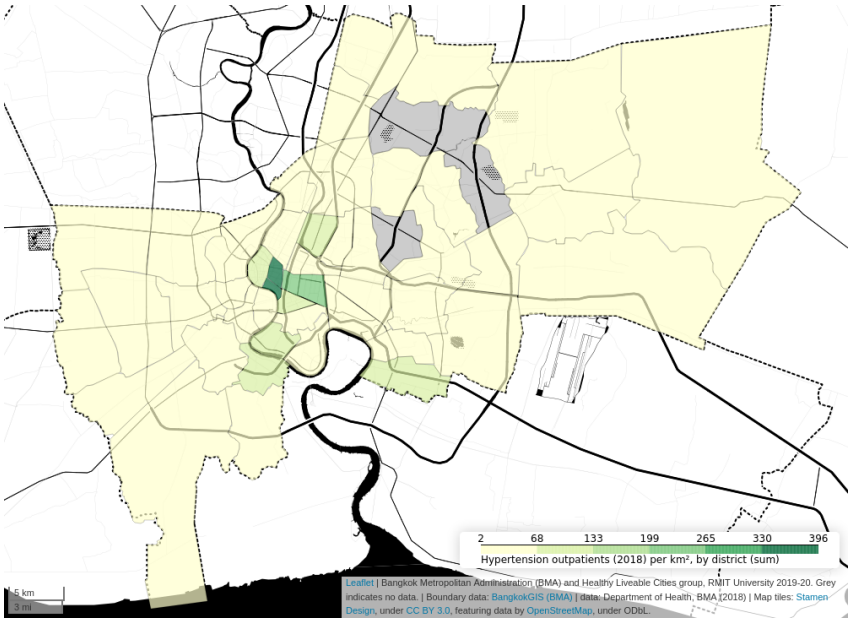


Fig. 245: Hypertension outpatients (2018) per km^2, by district

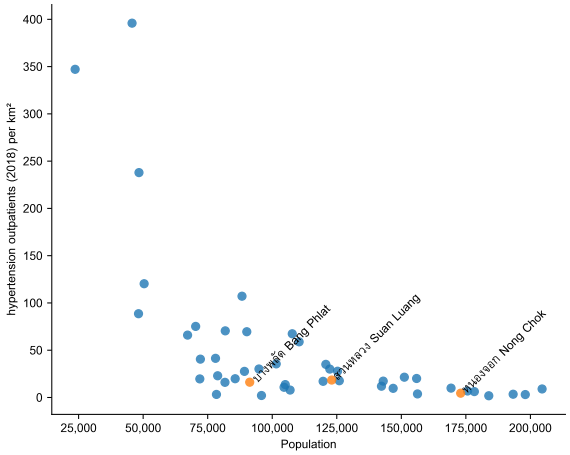


Fig. 246: Scatterplot of hypertension (2018) by population for districts.

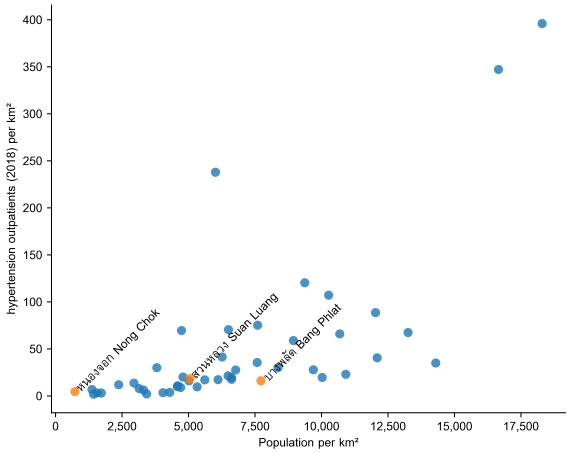


Fig. 247: Scatterplot of hypertension (2018) by population density for districts.

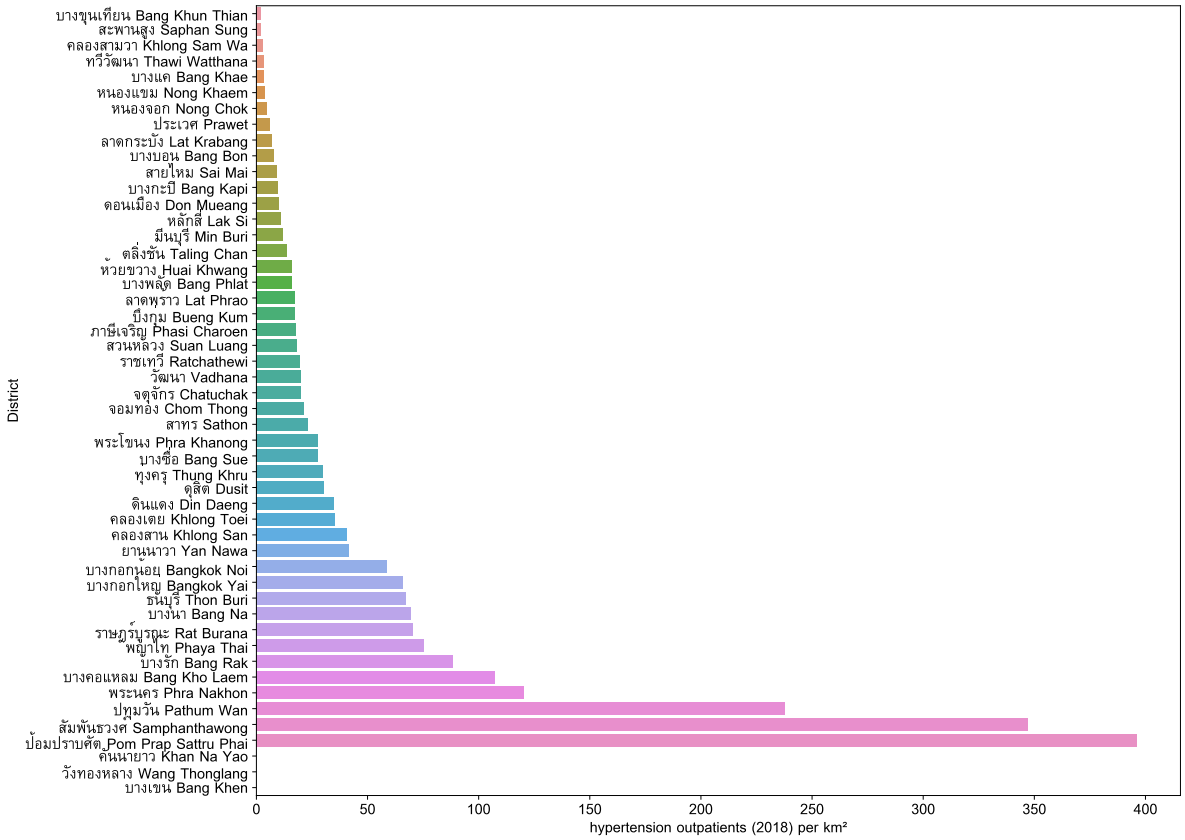


Fig. 248: Districts ranked in ascending order by hypertension (2018) with regard to hypertension outpatients (2018) per km^2.

Hypertension outpatients (2018) per 10,000 population

Outpatient numbers for hypertension were summed across each analysis area. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 3, 11.

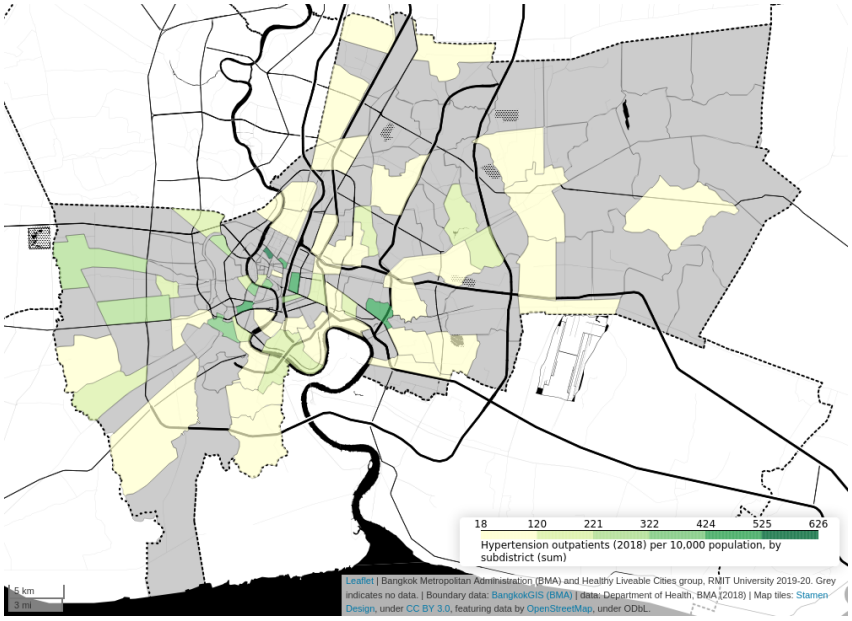


Fig. 249: Hypertension outpatients (2018) per 10,000 population, by subdistrict

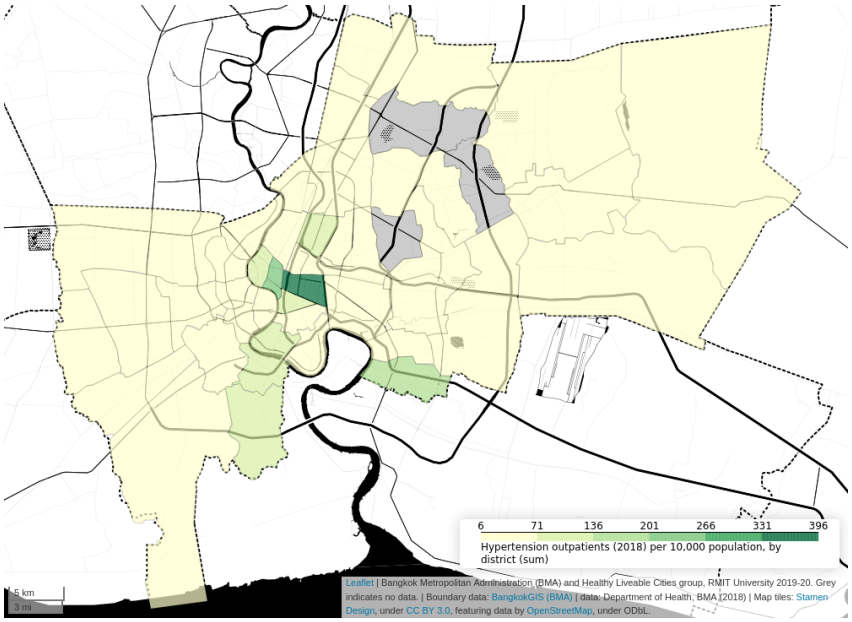


Fig. 250: Hypertension outpatients (2018) per 10,000 population, by district

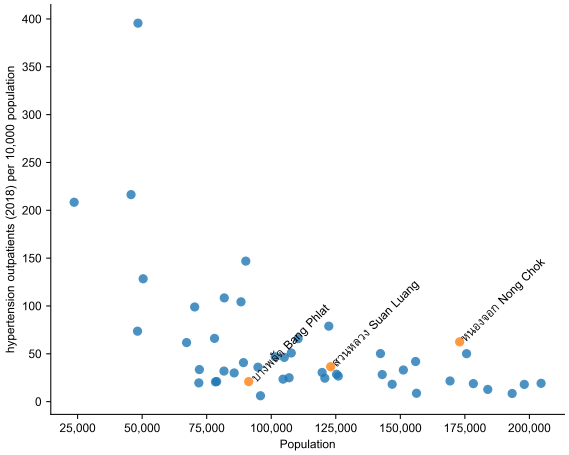


Fig. 251: Scatterplot of hypertension (2018) by population for districts.

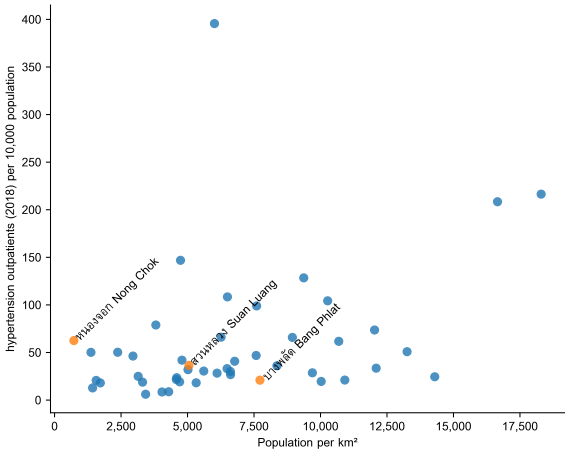


Fig. 252: Scatterplot of hypertension (2018) by population density for districts.

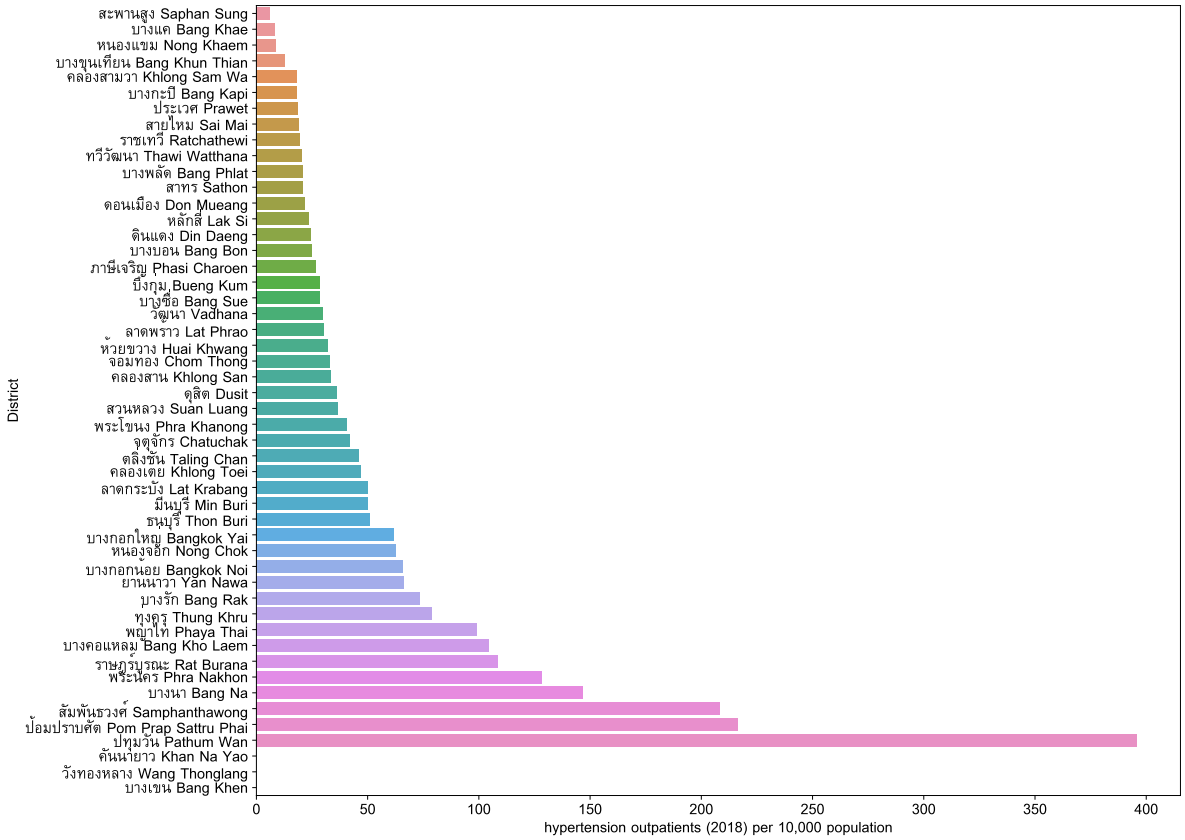


Fig. 253: Districts ranked in ascending order by hypertension (2018) with regard to hypertension outpatients (2018) per 10,000 population.

Hypertension outpatients (2018) per 10,000 household

Outpatient numbers for hypertension were summed across each analysis area. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 3, 11.

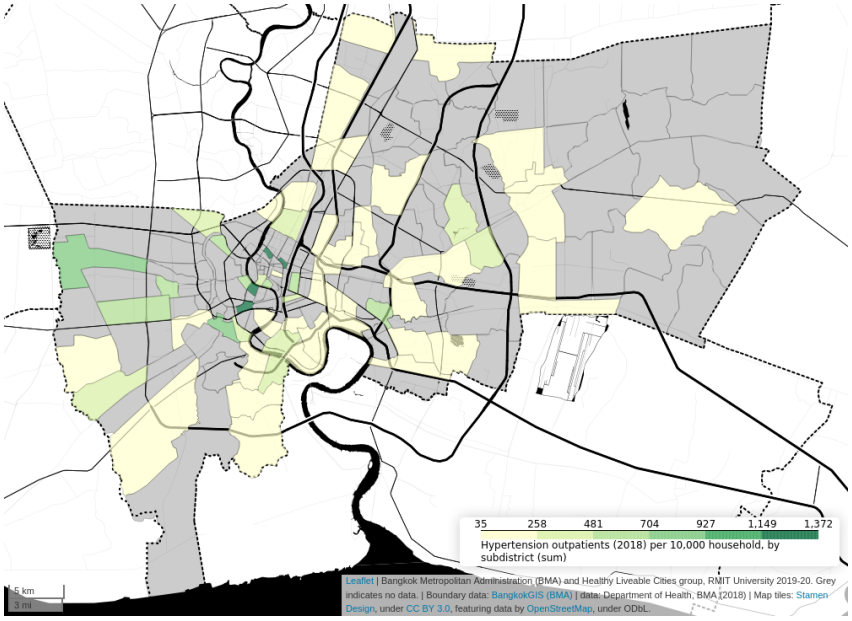


Fig. 254: Hypertension outpatients (2018) per 10,000 household, by subdistrict

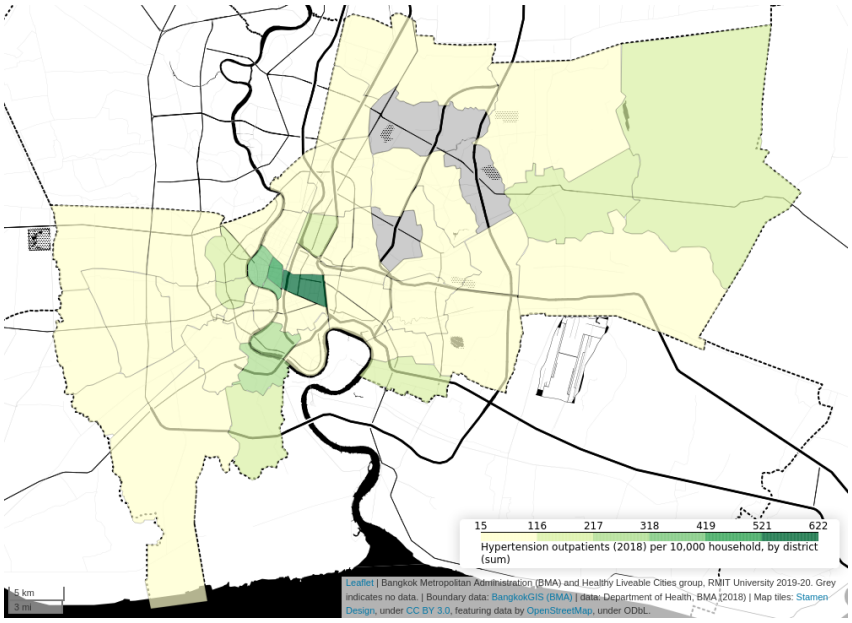


Fig. 255: Hypertension outpatients (2018) per 10,000 household, by district

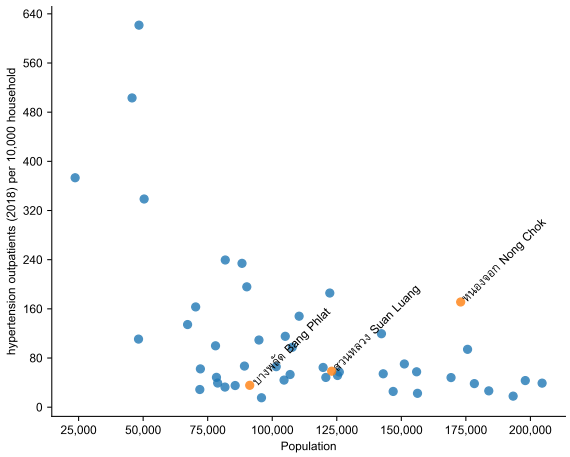


Fig. 256: Scatterplot of hypertension (2018) by population for districts.

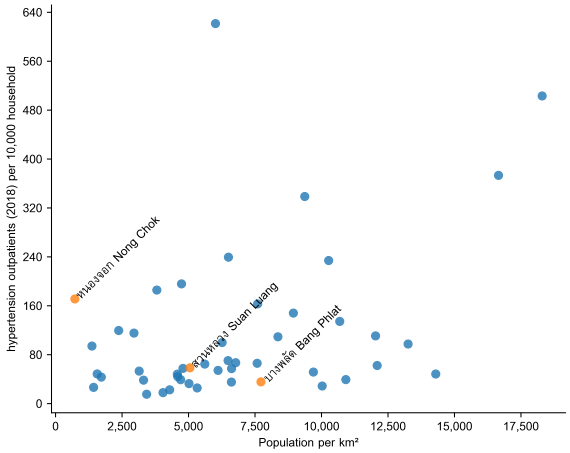


Fig. 257: Scatterplot of hypertension (2018) by population density for districts.

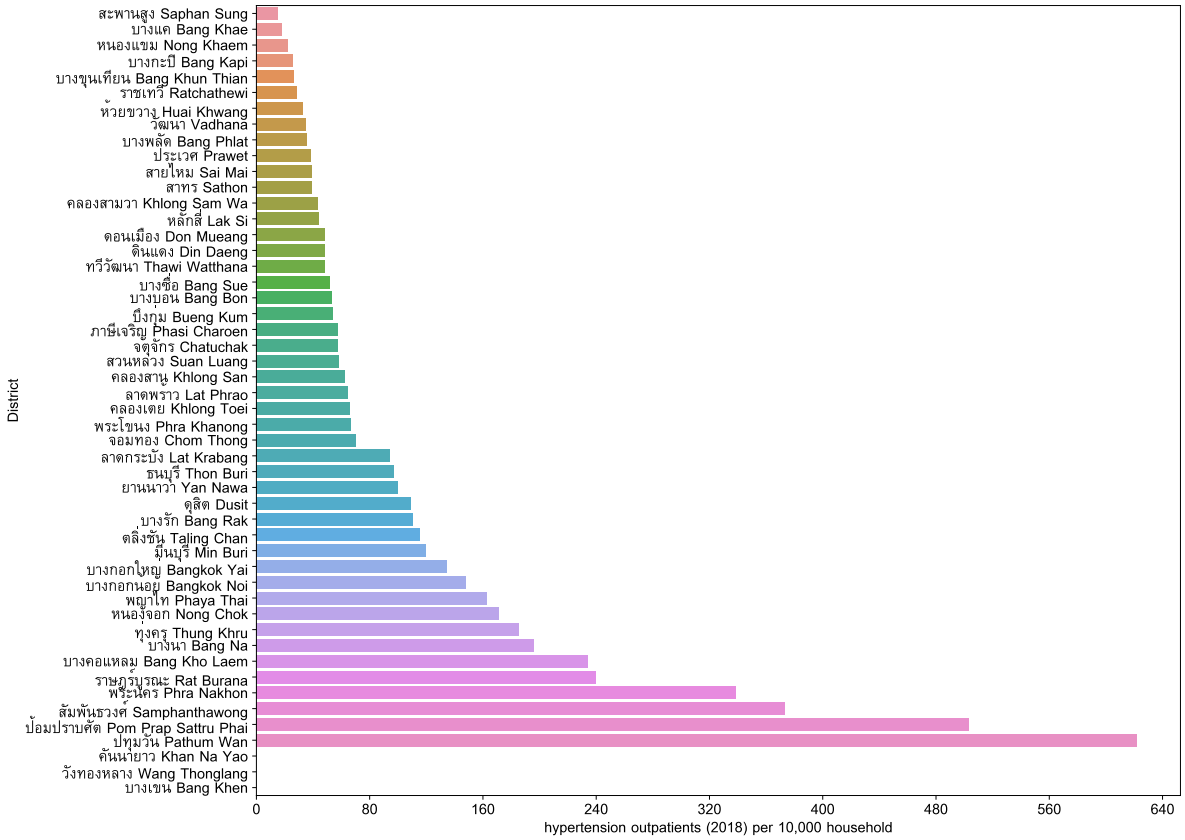


Fig. 258: Districts ranked in ascending order by hypertension (2018) with regard to hypertension outpatients (2018) per 10,000 household.

Diabetes outpatients (2018)

Outpatient numbers for diabetes were summed across each analysis area.

Aligns with Sustainable Development Goals: 3, 11.

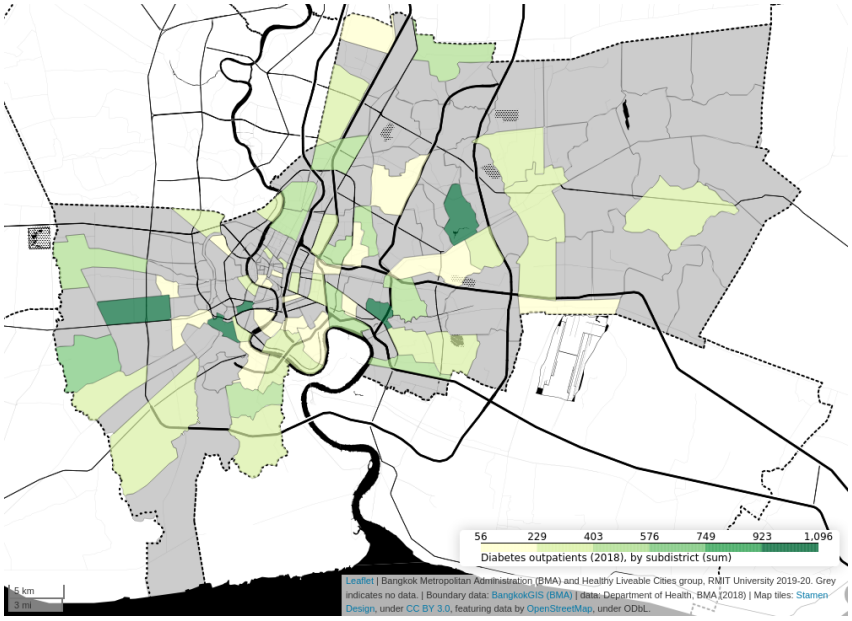


Fig. 259: Diabetes outpatients (2018), by subdistrict

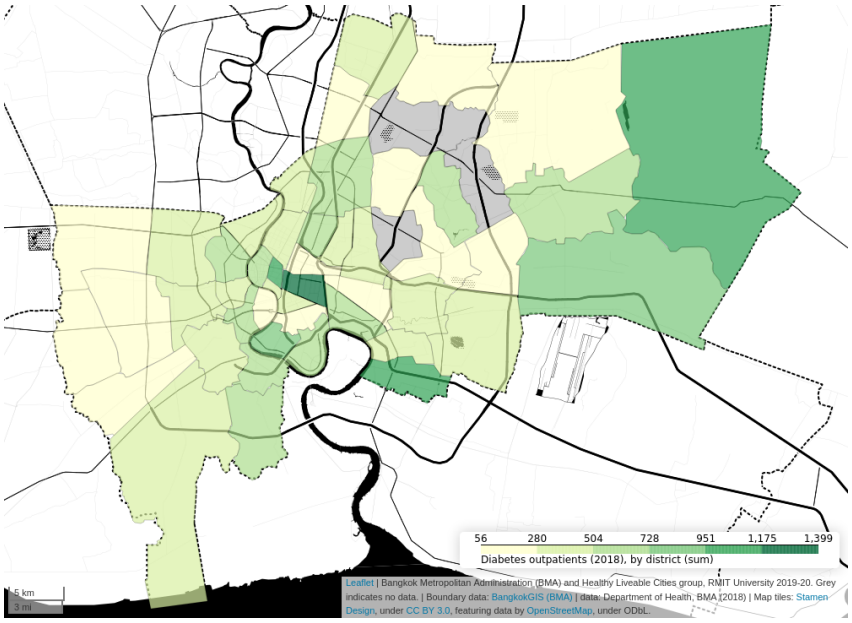


Fig. 260: Diabetes outpatients (2018), by district

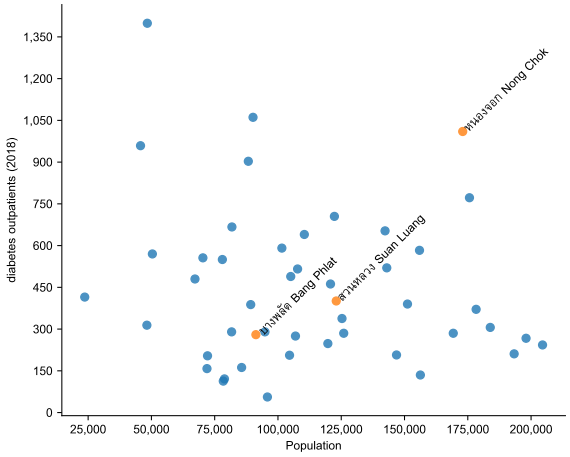


Fig. 261: Scatterplot of diabetes (2018) by population for districts.

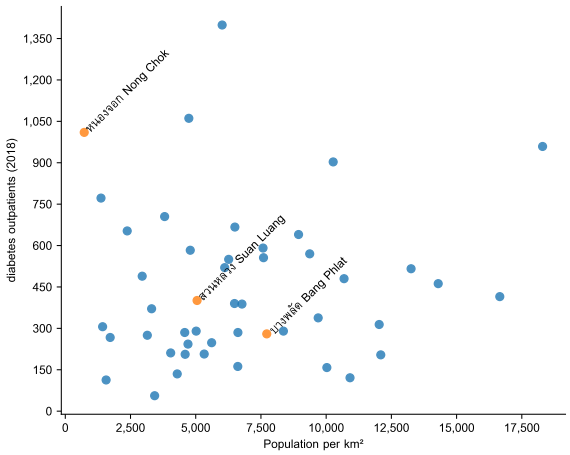


Fig. 262: Scatterplot of diabetes (2018) by population density for districts.

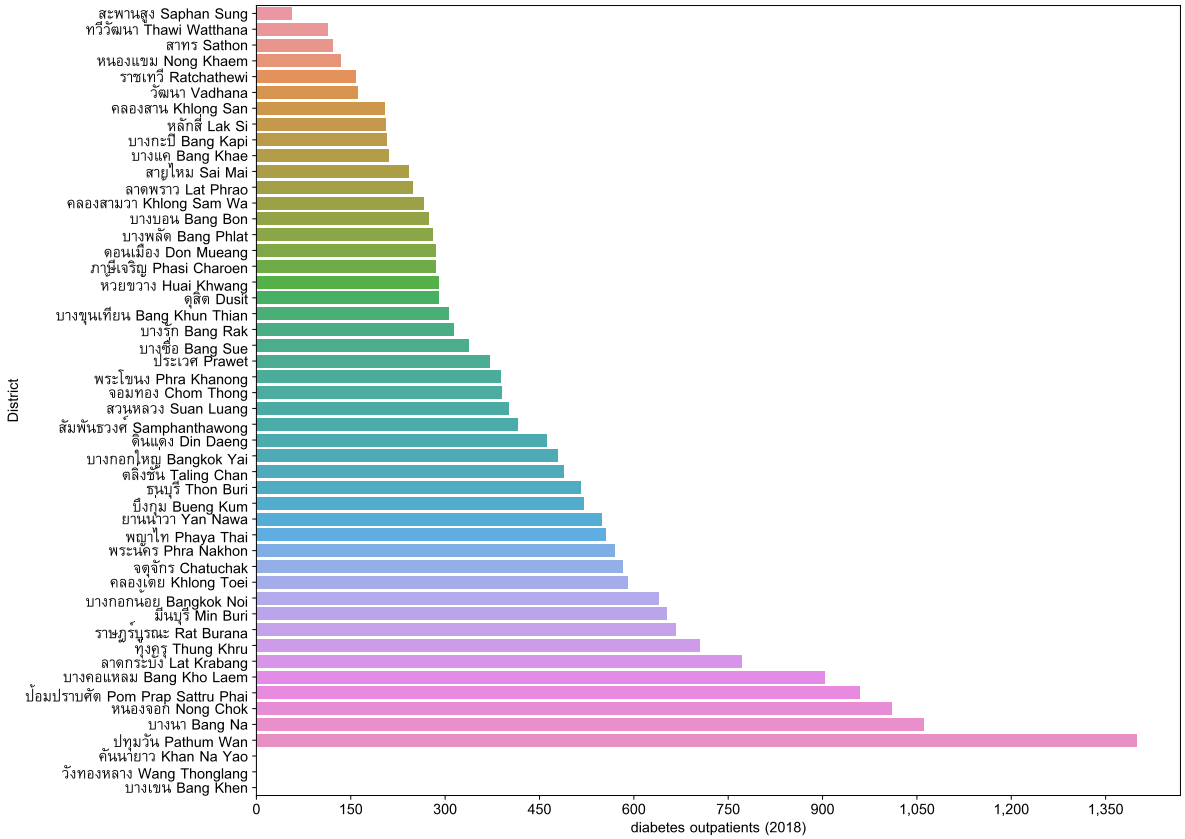


Fig. 263: Districts ranked in ascending order by diabetes (2018) with regard to diabetes outpatients (2018).

Diabetes outpatients (2018) per km²

Outpatient numbers for diabetes were summed across each analysis area. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 3, 11.

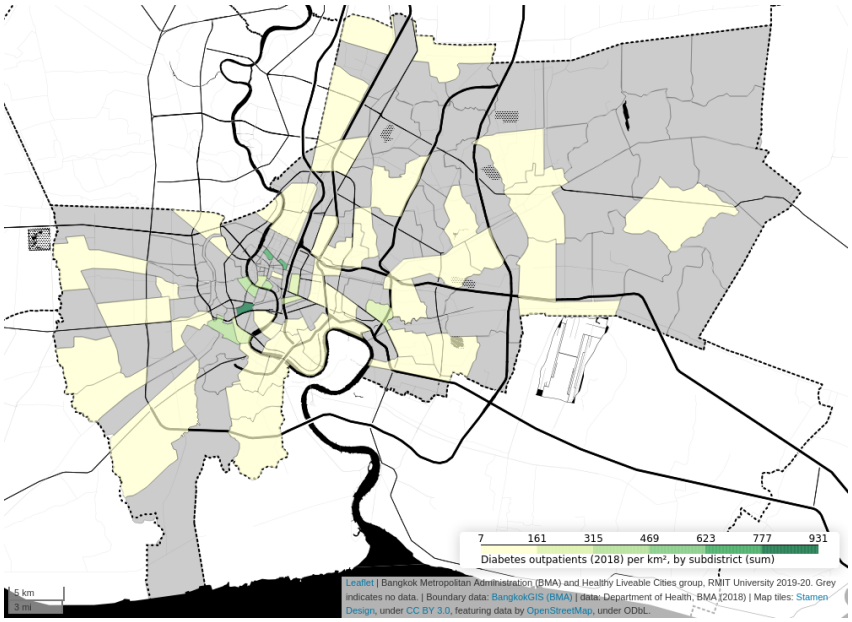


Fig. 264: Diabetes outpatients (2018) per km^2, by subdistrict

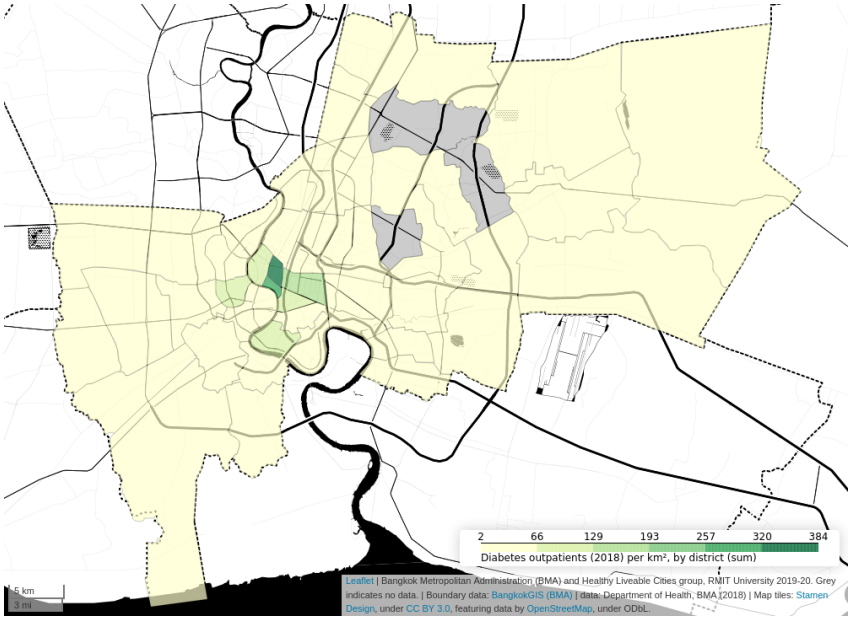


Fig. 265: Diabetes outpatients (2018) per km^2, by district

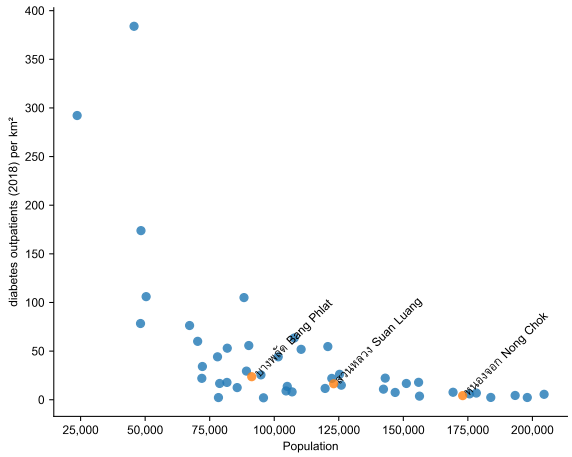


Fig. 266: Scatterplot of diabetes (2018) by population for districts.

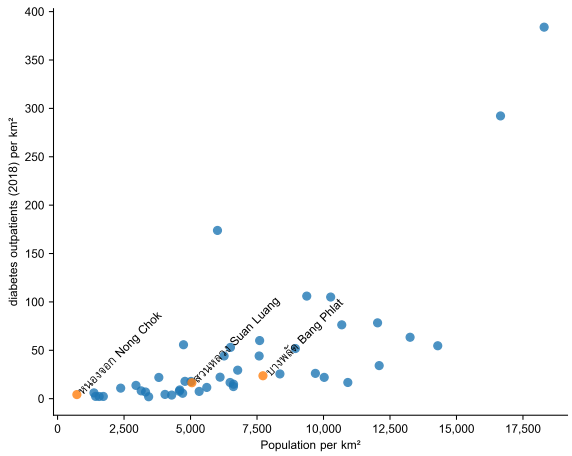


Fig. 267: Scatterplot of diabetes (2018) by population density for districts.

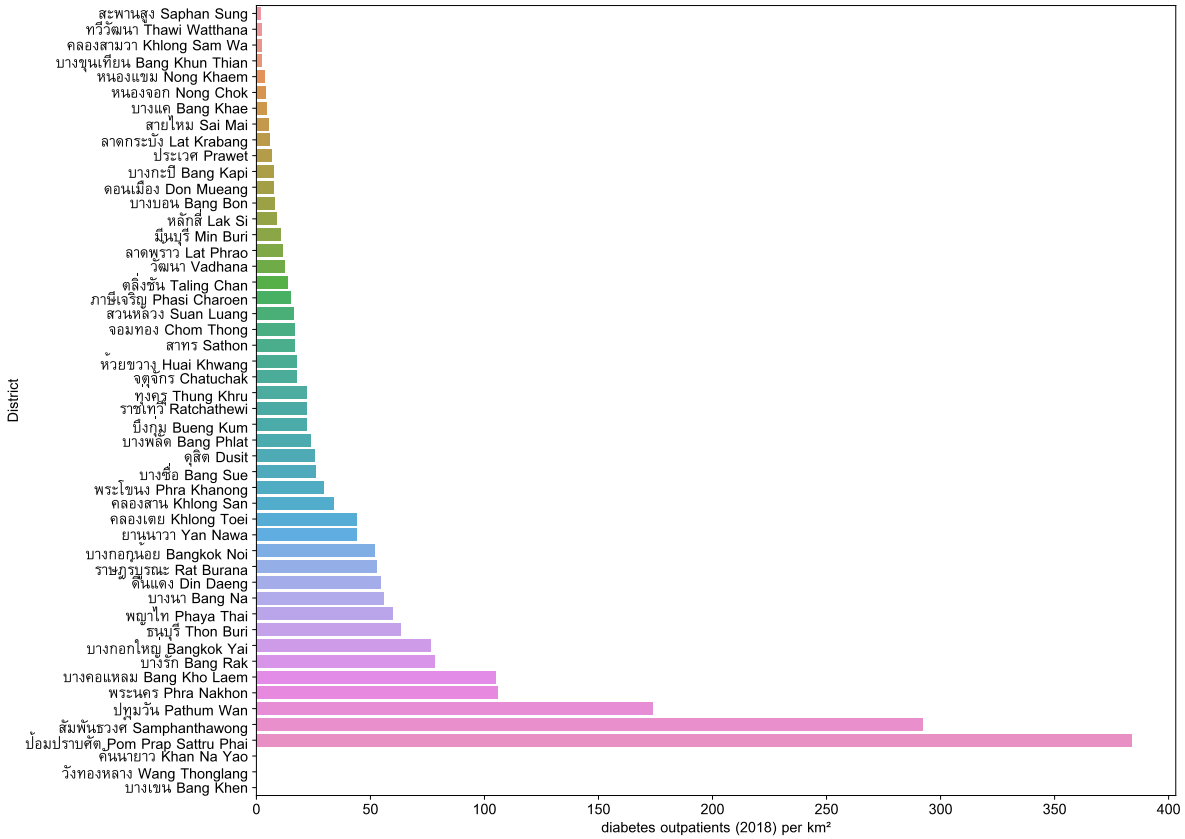


Fig. 268: Districts ranked in ascending order by diabetes (2018) with regard to diabetes outpatients (2018) per km^2.

Diabetes outpatients (2018) per 10,000 population

Outpatient numbers for diabetes were summed across each analysis area. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 3, 11.

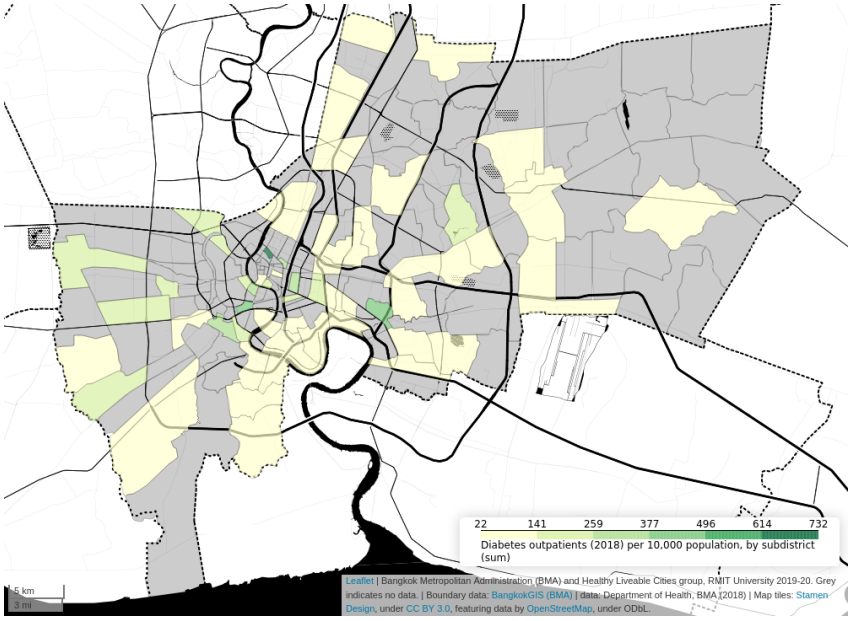


Fig. 269: Diabetes outpatients (2018) per 10,000 population, by subdistrict

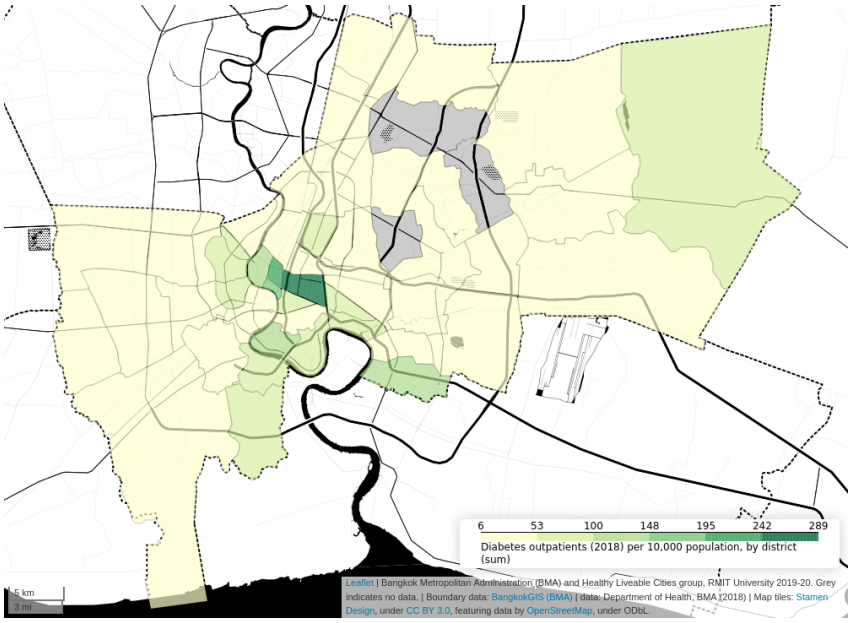


Fig. 270: Diabetes outpatients (2018) per 10,000 population, by district

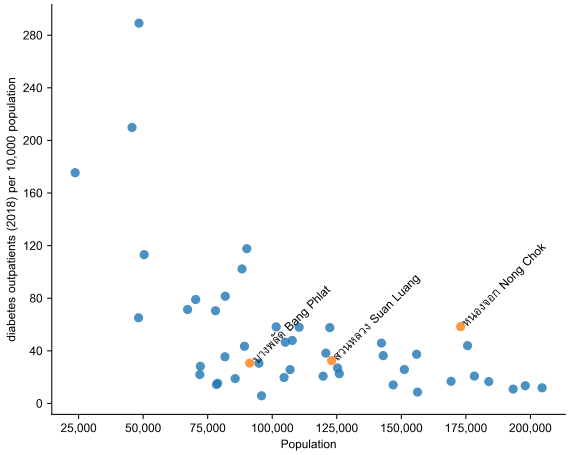


Fig. 271: Scatterplot of diabetes (2018) by population for districts.

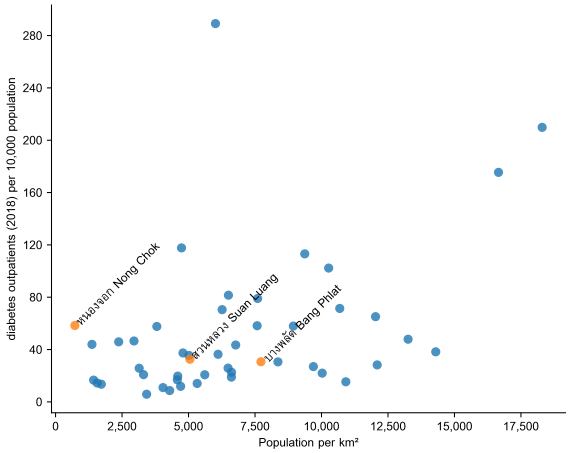


Fig. 272: Scatterplot of diabetes (2018) by population density for districts.

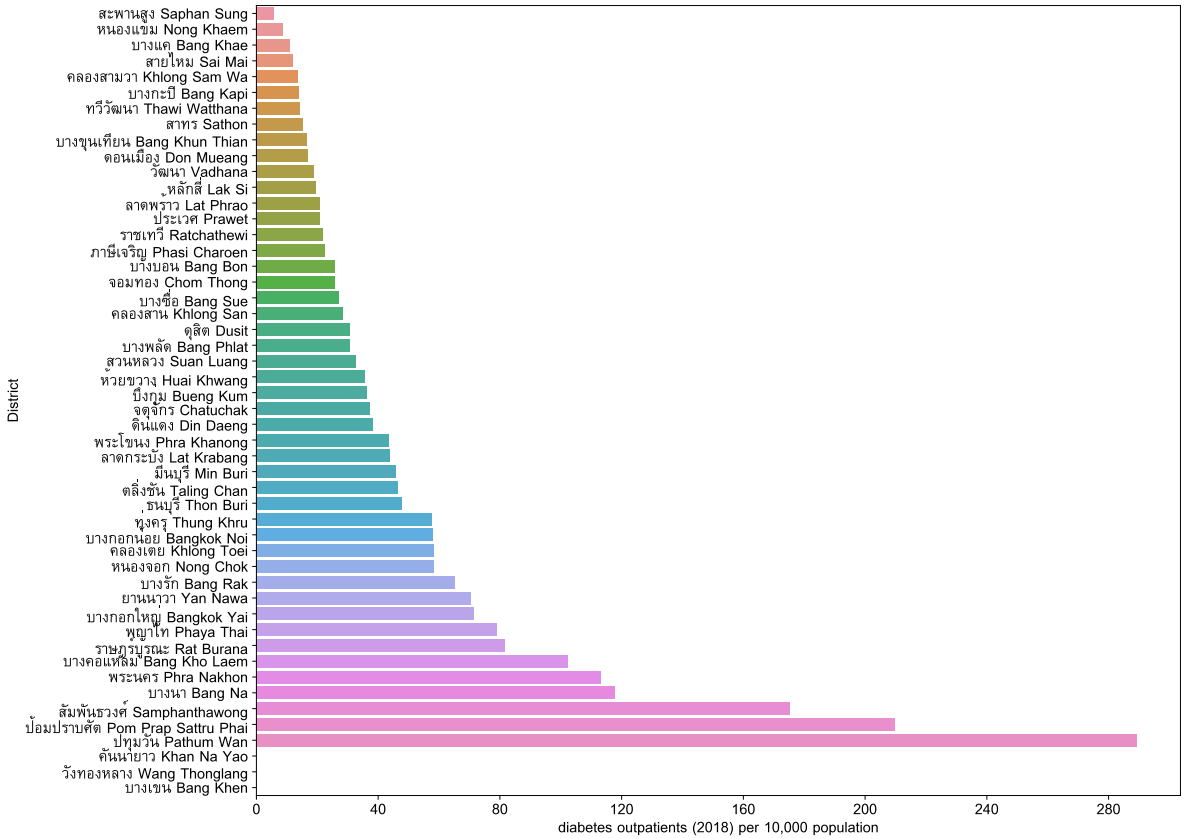


Fig. 273: Districts ranked in ascending order by diabetes (2018) with regard to diabetes outpatients (2018) per 10,000 population.

Diabetes outpatients (2018) per 10,000 household

Outpatient numbers for diabetes were summed across each analysis area. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 3, 11.

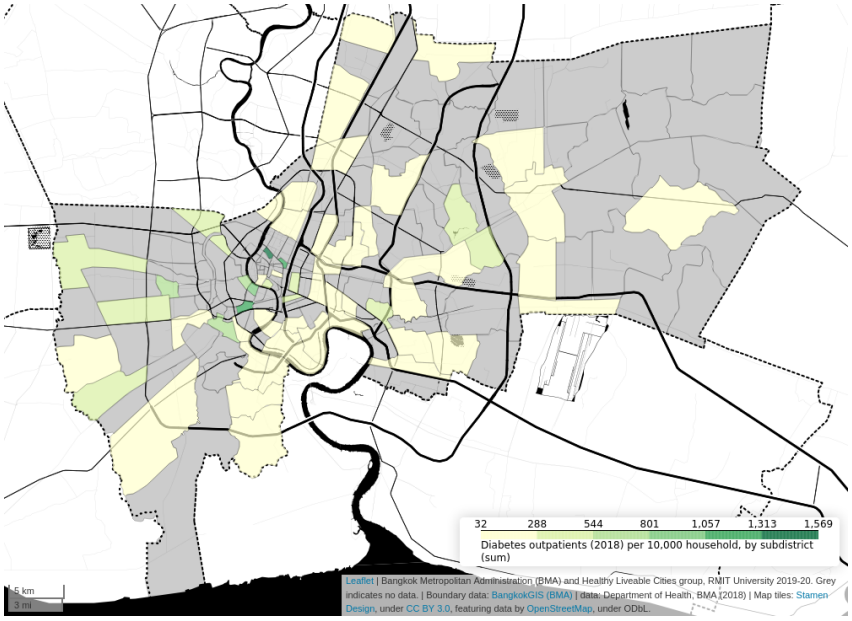


Fig. 274: Diabetes outpatients (2018) per 10,000 household, by subdistrict

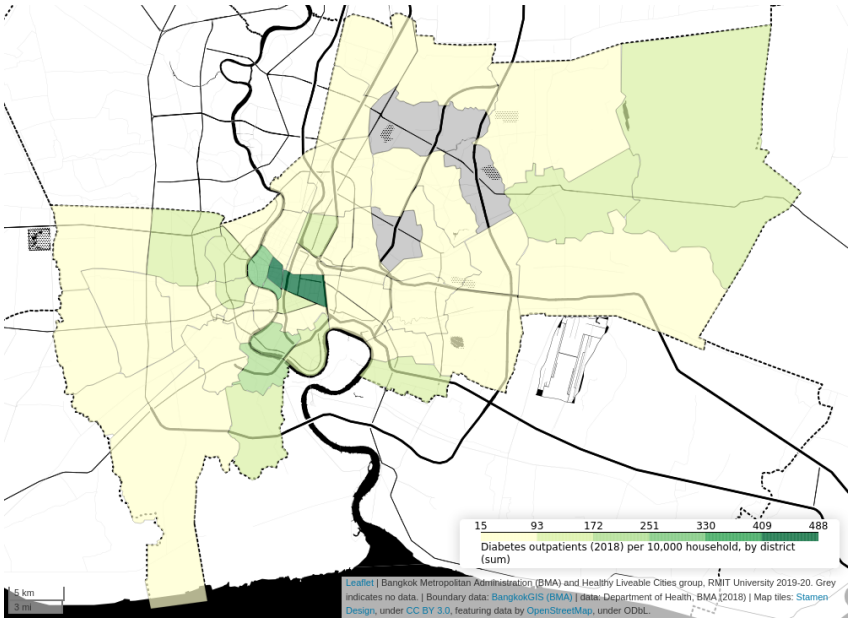


Fig. 275: Diabetes outpatients (2018) per 10,000 household, by district

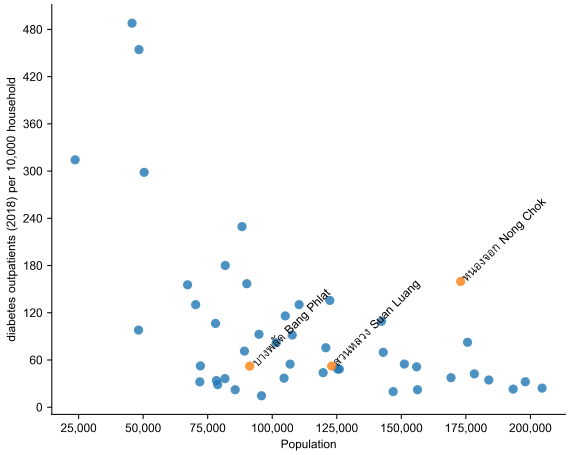


Fig. 276: Scatterplot of diabetes (2018) by population for districts.

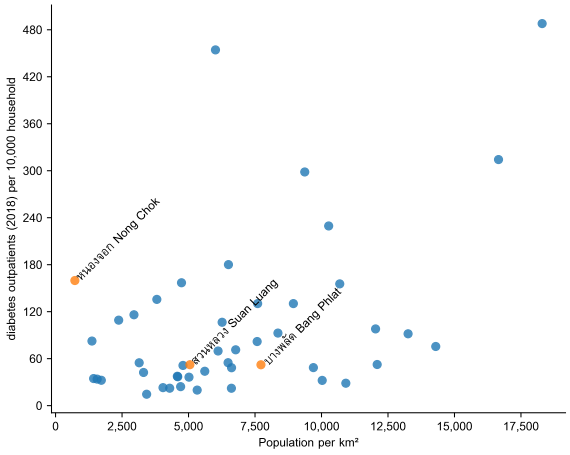


Fig. 277: Scatterplot of diabetes (2018) by population density for districts.

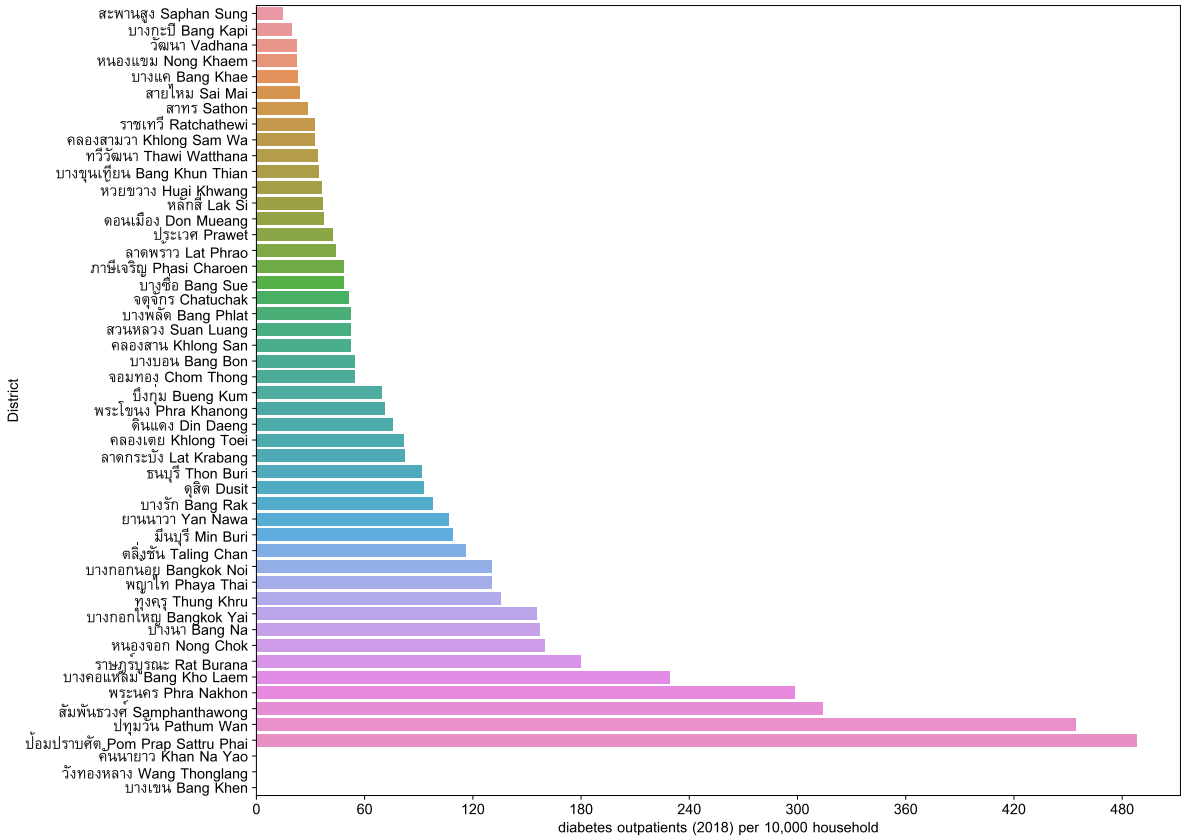


Fig. 278: Districts ranked in ascending order by diabetes (2018) with regard to diabetes outpatients (2018) per 10,000 household.

2.5.3 Quality food

อาหารมีคุณภาพ

Food safety refers to the practice and conditions of maintaining food quality to prevent contamination and foodborne illnesses during preparation, management and storage. Food quality refers to properties and characteristics of food products that are acceptable to consumers and meet expectations of safety and value for money.

Dataset: Vital diseases

Data at subdistrict level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `Department of Health, BMA`

Publication year: `2018`

Target year: `2018`

Acquisition date (yyyymmdd): `20190617`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190617/vital diseases HC BMA 2018.xlsx`

Vital diseases (combined, 2018)

Outpatient numbers for all vital diseases (mental and behavioural disorders, hypertension, and diabetes) were summed across each analysis area.

Aligns with Sustainable Development Goals: 3, 11.

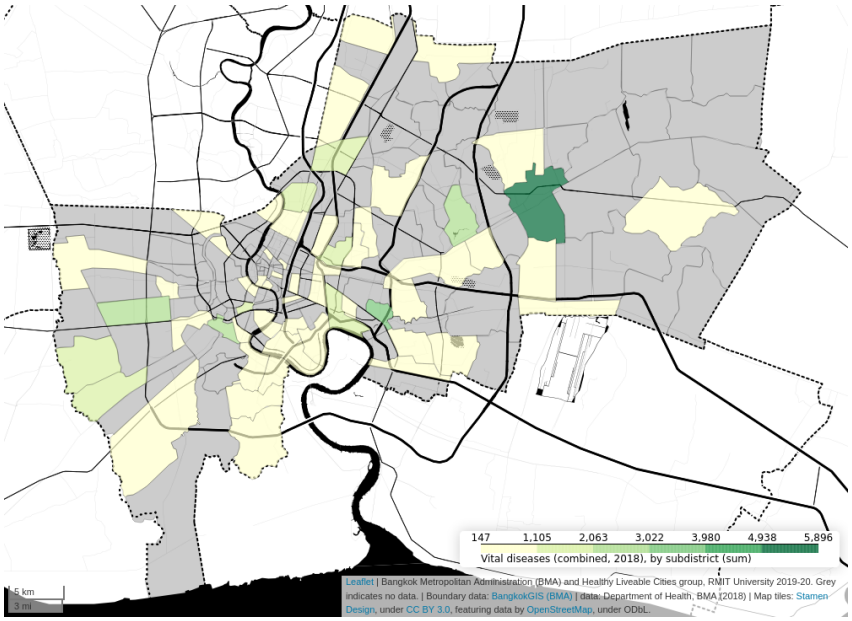


Fig. 279: Vital diseases (combined, 2018), by subdistrict

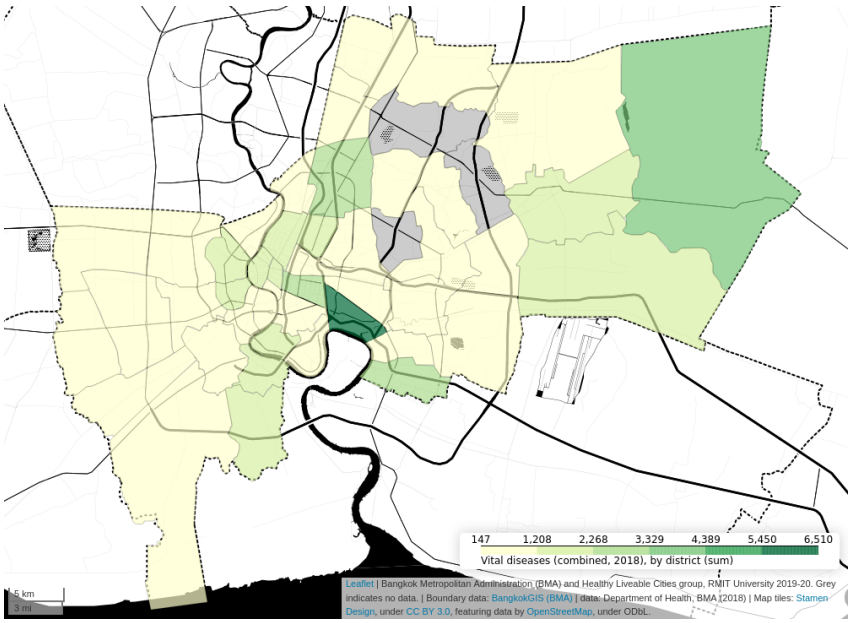


Fig. 280: Vital diseases (combined, 2018), by district

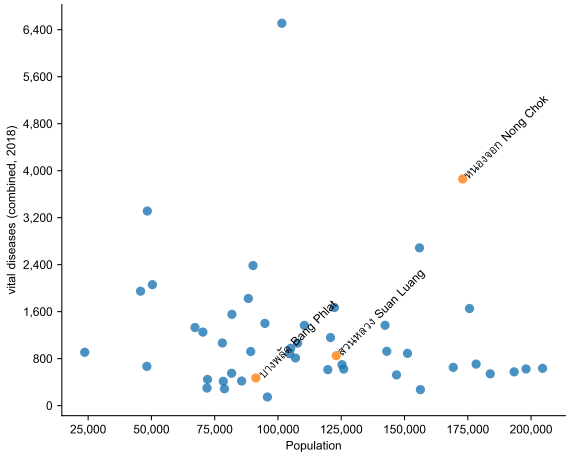


Fig. 281: Scatterplot of vital diseases (combined; 2018) by population for districts.

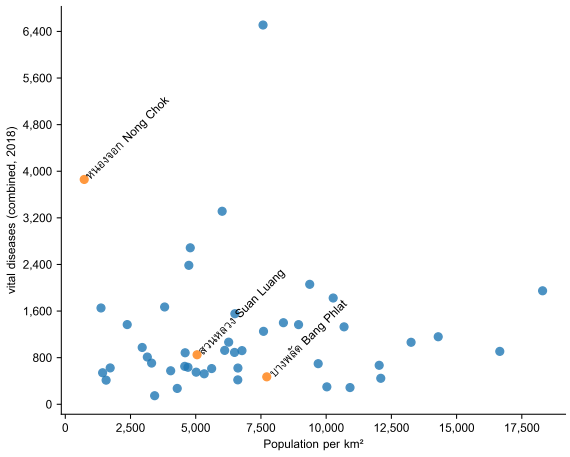


Fig. 282: Scatterplot of vital diseases (combined; 2018) by population density for districts.

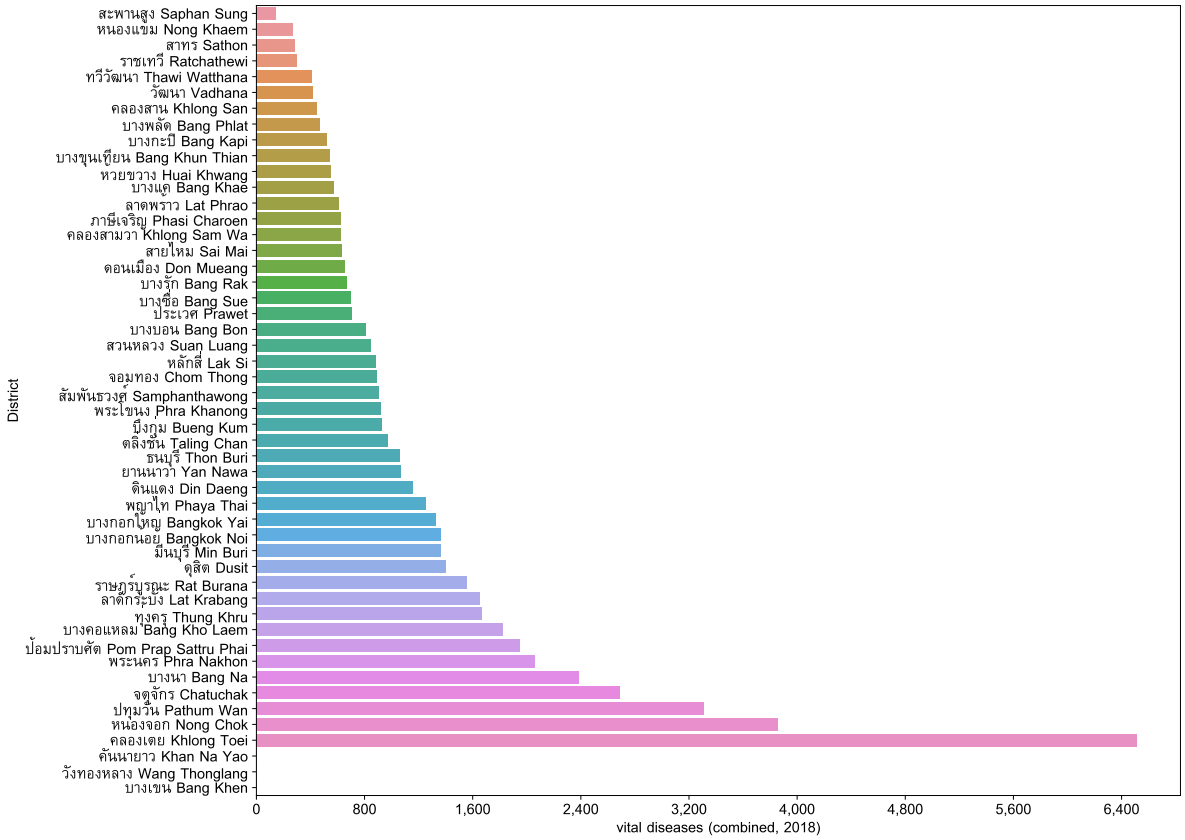


Fig. 283: Districts ranked in ascending order by vital diseases (combined; 2018) with regard to vital diseases (combined, 2018).

Vital diseases (combined, 2018) per km^2

Outpatient numbers for all vital diseases (mental and behavioural disorders, hypertension, and diabetes) were summed across each analysis area. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 3, 11.

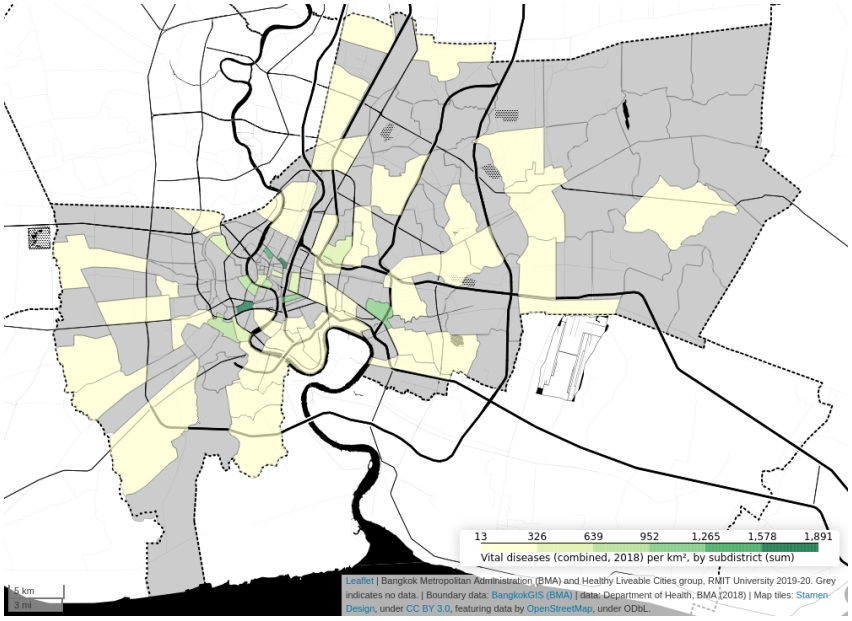


Fig. 284: Vital diseases (combined, 2018) per km^2, by subdistrict

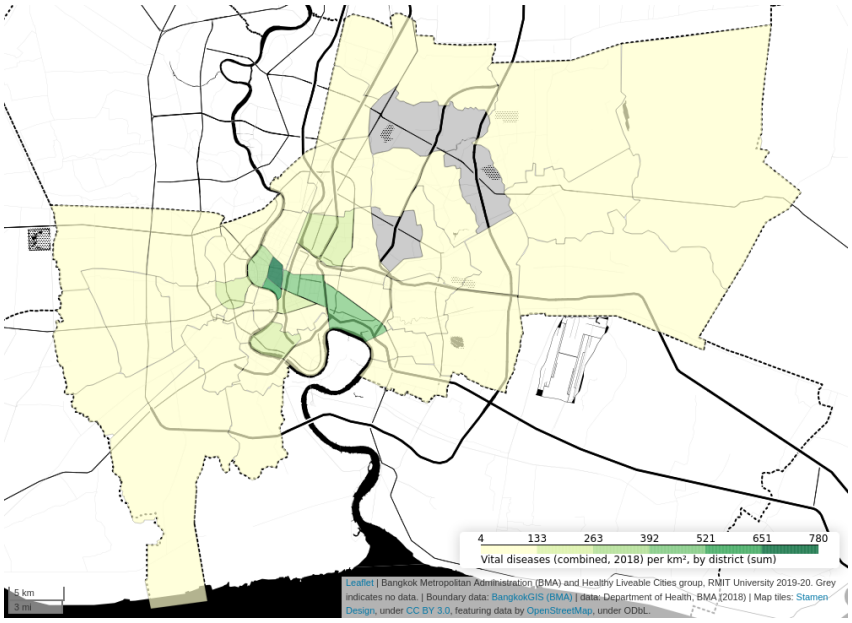


Fig. 285: Vital diseases (combined, 2018) per km^2, by district

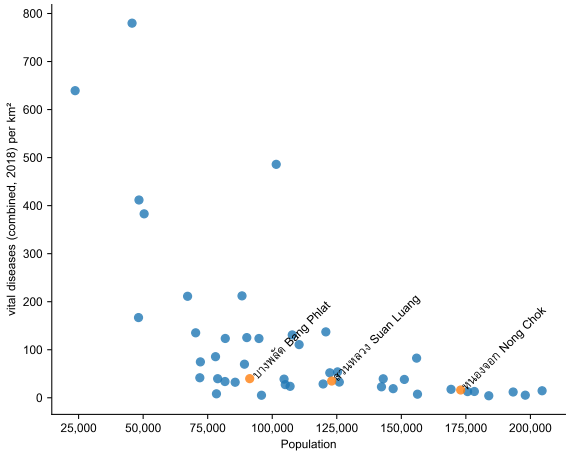


Fig. 286: Scatterplot of vital diseases (combined; 2018) by population for districts.

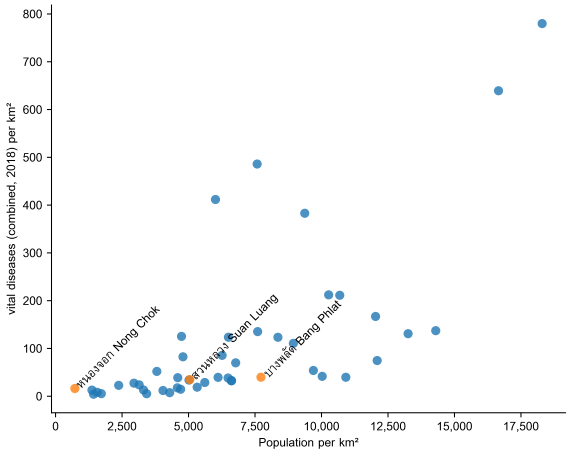


Fig. 287: Scatterplot of vital diseases (combined; 2018) by population density for districts.

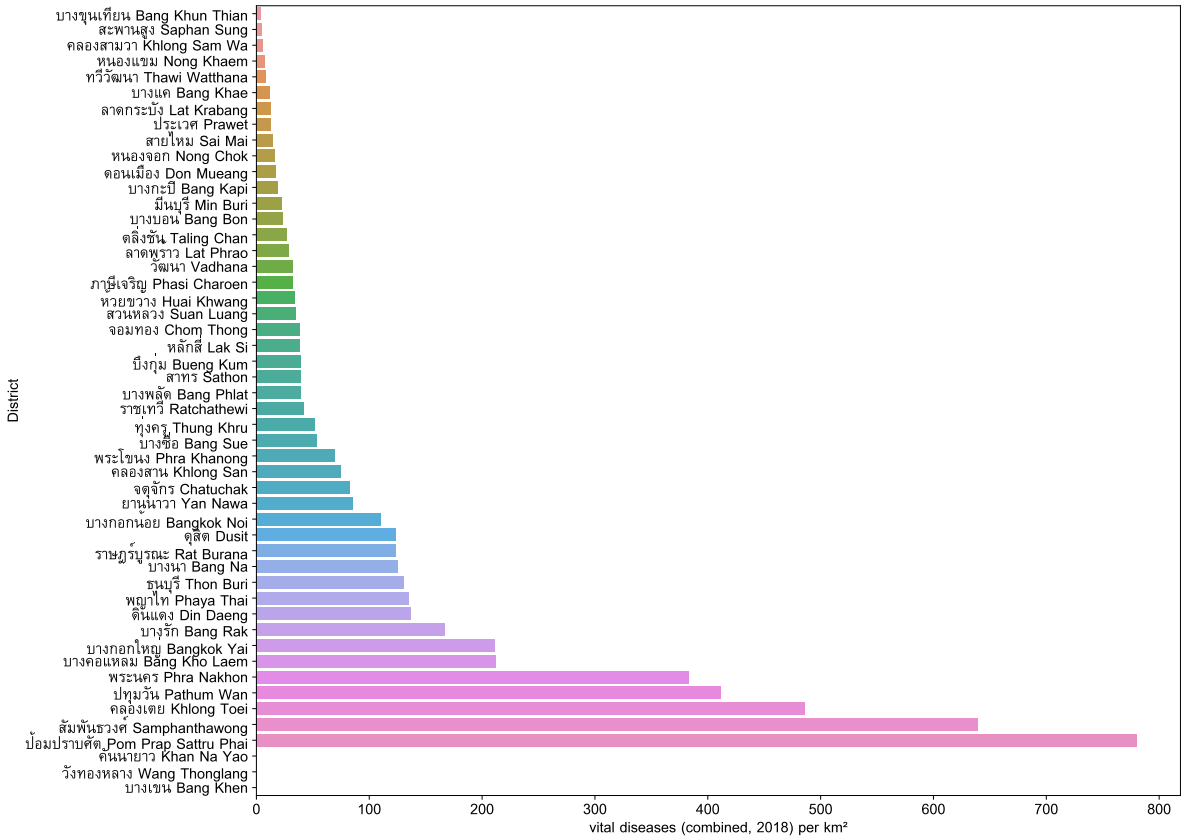


Fig. 288: Districts ranked in ascending order by vital diseases (combined; 2018) with regard to vital diseases (combined, 2018) per km^2.

Vital diseases (combined, 2018) per 10,000 population

Outpatient numbers for all vital diseases (mental and behavioural disorders, hypertension, and diabetes) were summed across each analysis area. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 3, 11.

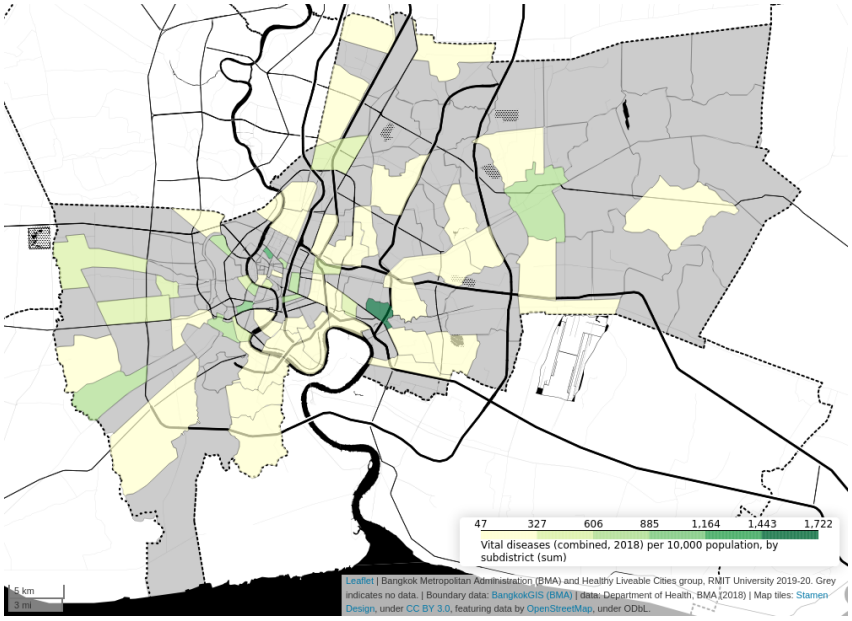


Fig. 289: Vital diseases (combined, 2018) per 10,000 population, by subdistrict

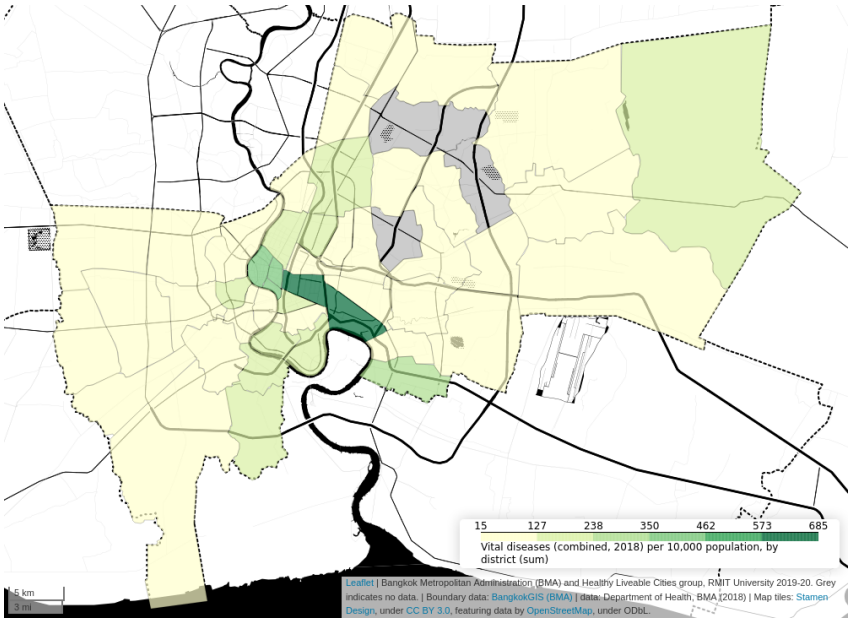


Fig. 290: Vital diseases (combined, 2018) per 10,000 population, by district

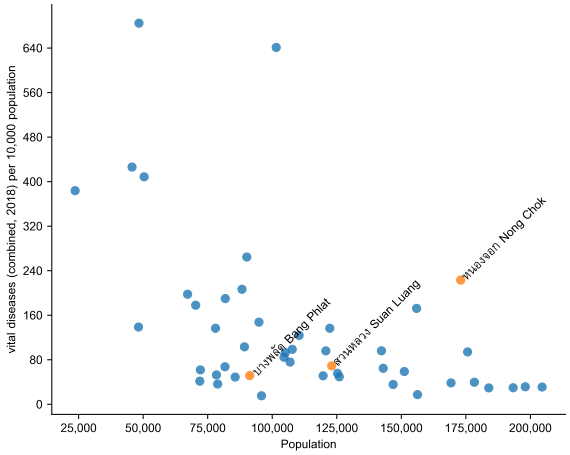


Fig. 291: Scatterplot of vital diseases (combined; 2018) by population for districts.

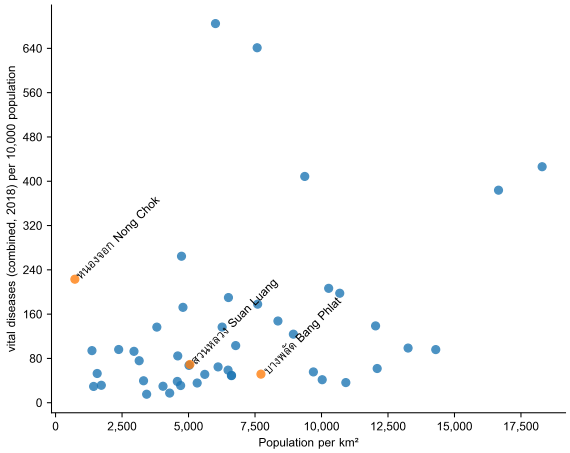


Fig. 292: Scatterplot of vital diseases (combined; 2018) by population density for districts.

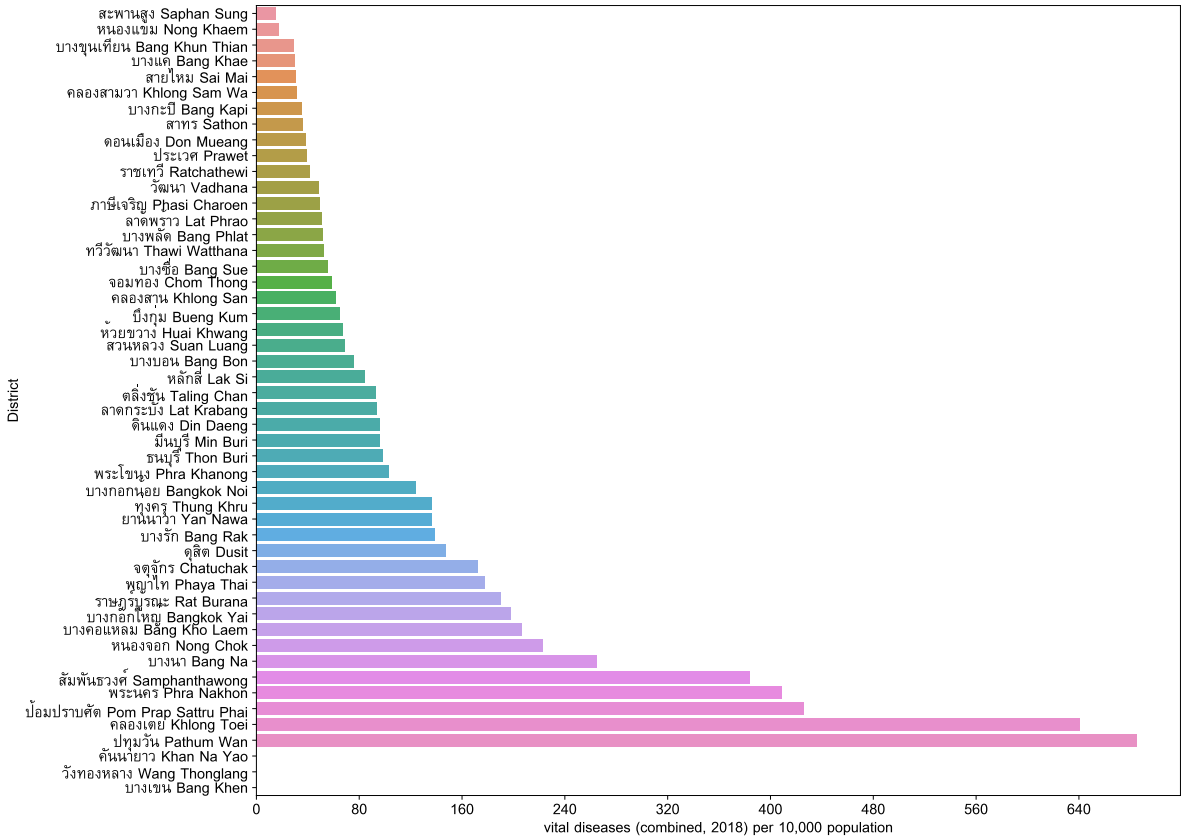


Fig. 293: Districts ranked in ascending order by vital diseases (combined; 2018) with regard to vital diseases (combined, 2018) per 10,000 population.

Vital diseases (combined, 2018) per 10,000 household

Outpatient numbers for all vital diseases (mental and behavioural disorders, hypertension, and diabetes) were summed across each analysis area. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 3, 11.

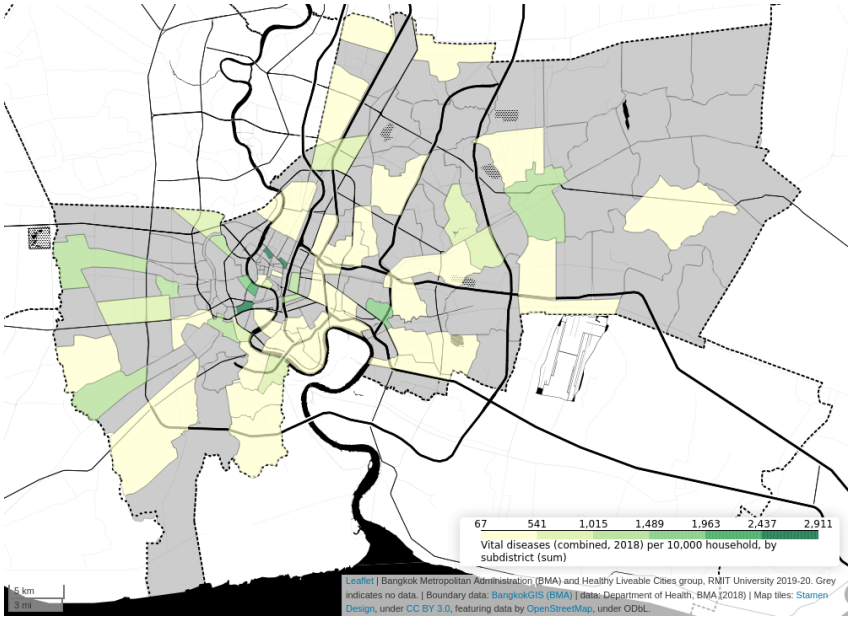


Fig. 294: Vital diseases (combined, 2018) per 10,000 household, by subdistrict

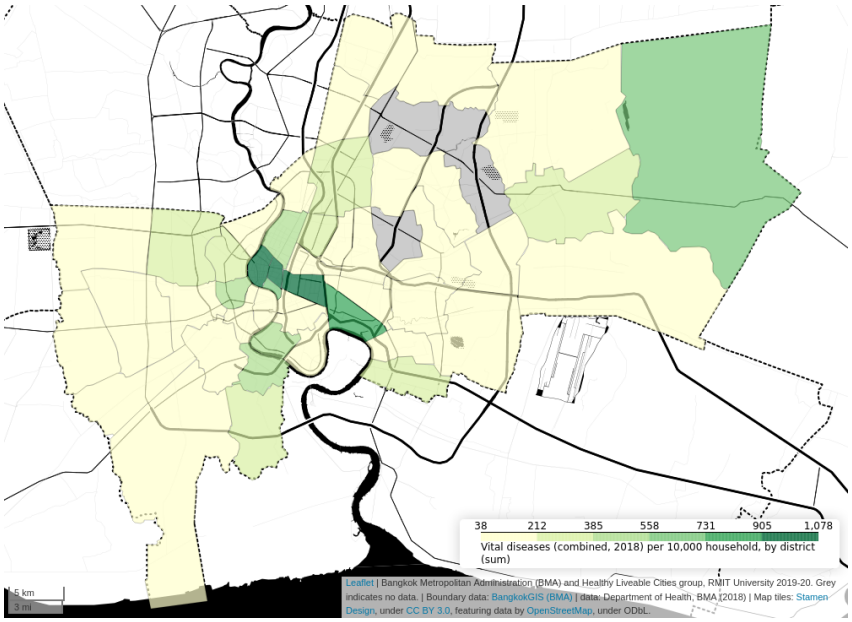


Fig. 295: Vital diseases (combined, 2018) per 10,000 household, by district

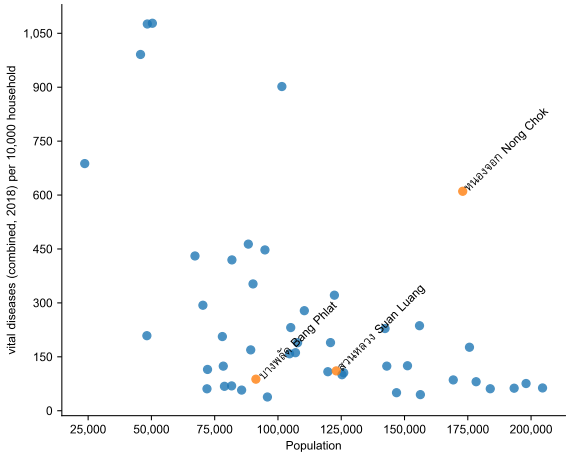


Fig. 296: Scatterplot of vital diseases (combined; 2018) by population for districts.

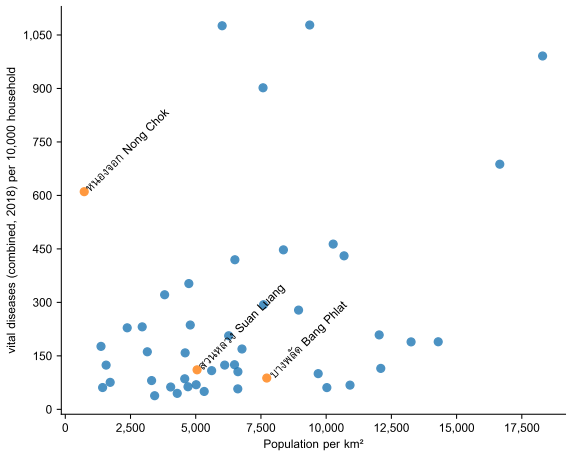


Fig. 297: Scatterplot of vital diseases (combined; 2018) by population density for districts.

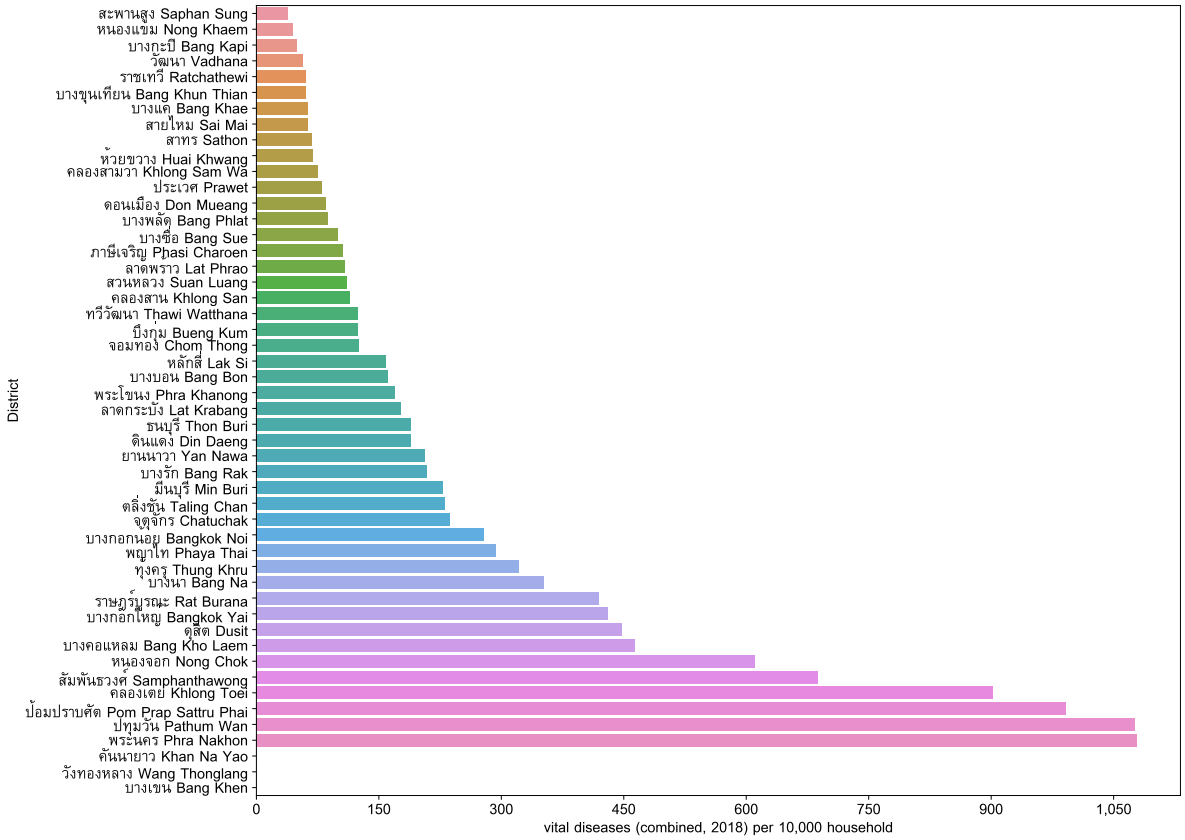


Fig. 298: Districts ranked in ascending order by vital diseases (combined; 2018) with regard to vital diseases (combined, 2018) per 10,000 household.

Dataset: Supermarket acccess

Supermarket locations identified through key-value pair tags according to OSM guidelines or common usage patterns identified from OSM Taginfo were analysed for accessibility using a pedestrian network derived from OSM data using OSMnx.

Data source: `OpenStreetMap`

Publication year: `2019`

Target year: `2019`

Acquisition date (yyyymmdd): `20191007`

Licence: `ODbL`

Licence URL: `https://wiki.osmfoundation.org/wiki/Licence`

Scale / Resolution: `800`

Percentage of residents living 800 metres distance of a supermarket (2019)

Accessibility within 800m was evaluated using the Python network analysis package Pandana for a series of sample points generated every 50 metres along the Bangkok OSM pedestrian network. Population weighted averages for the proportion of sample points having access in each subdistrict were used to estimate the measure.

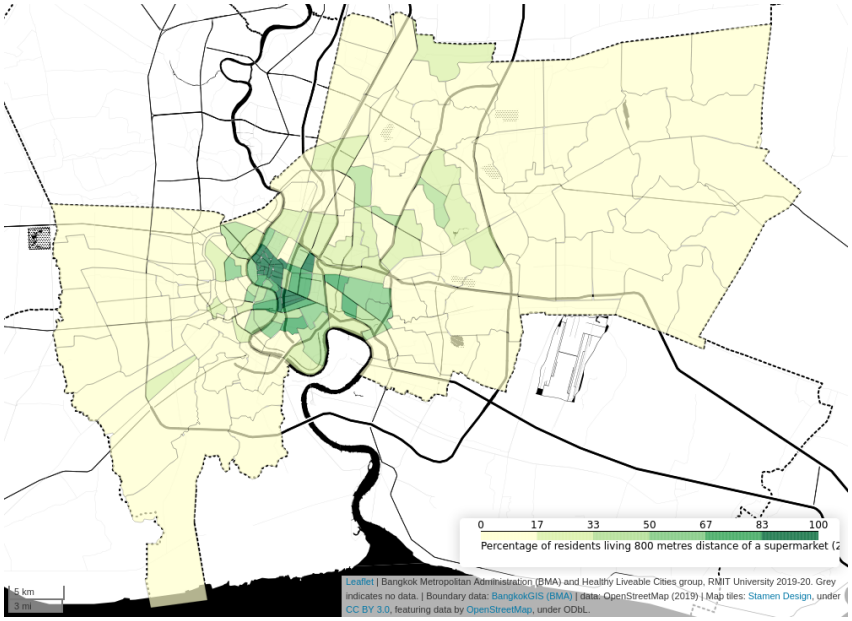


Fig. 299: Percentage of residents living 800 metres distance of a supermarket (2019), by subdistrict

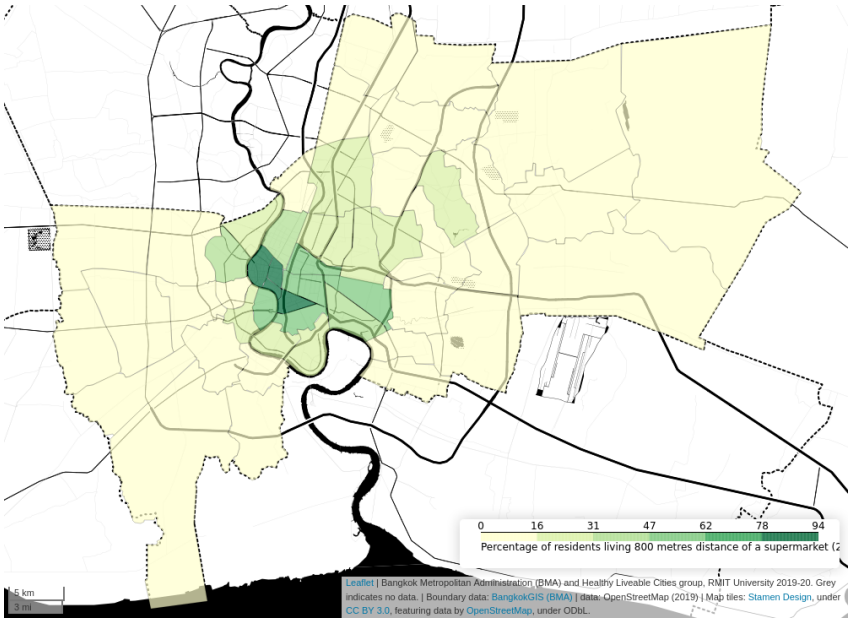


Fig. 300: Percentage of residents living 800 metres distance of a supermarket (2019), by district

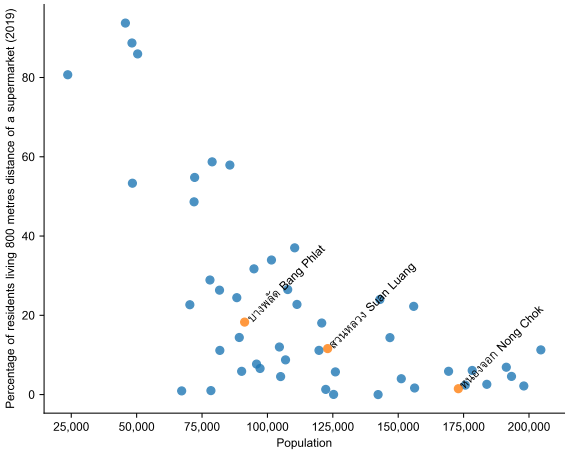


Fig. 301: Scatterplot of Percentage of residents living 800 metres distance of a supermarket (OSM, 2019) by population for districts.

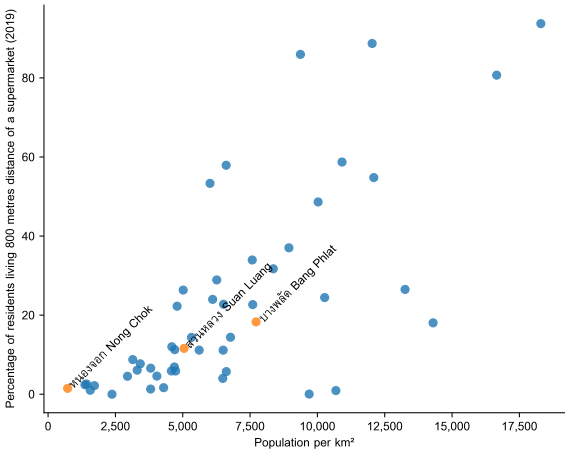


Fig. 302: Scatterplot of Percentage of residents living 800 metres distance of a supermarket (OSM, 2019) by population density for districts.

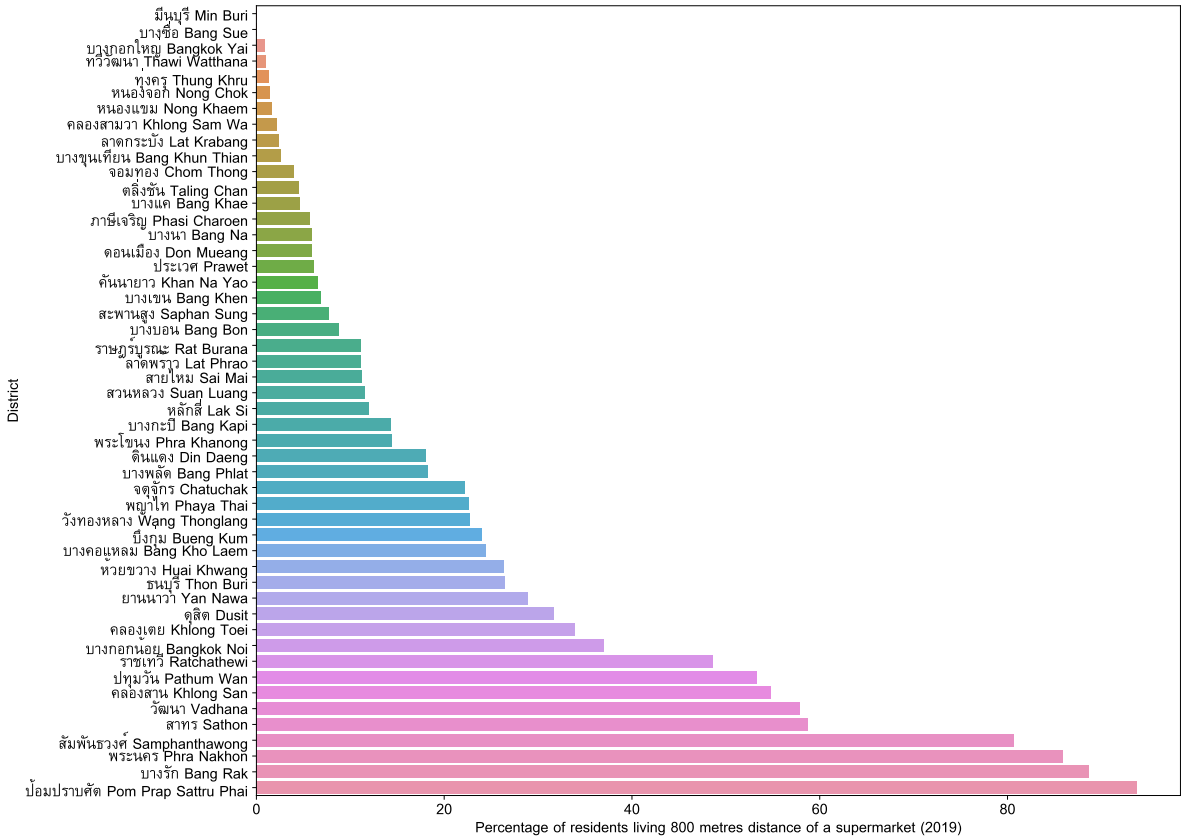


Fig. 303: Districts ranked in ascending order by percentage of residents living 800 metres distance of a supermarket (osm, 2019) with regard to percentage of residents living 800 metres distance of a supermarket (2019).

Dataset: Food entrepreneurs

Data comprising counts of restaurants, supermarkets, minimarts, stalls and markets for each district were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `Department of Environment and Sanitation, BMA`

Publication year: `2019`

Target year: `2018`

Acquisition date (yyyymmdd): `20190820`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190820/transfer_1682928_files_504fdeaf/Num of food entrepreneur in Bangkok 2019 -kn15819.xlsx`

Number of restaurants (2019)

The number of restaurants within each analysis area was recorded.

Aligns with Sustainable Development Goals: 11.

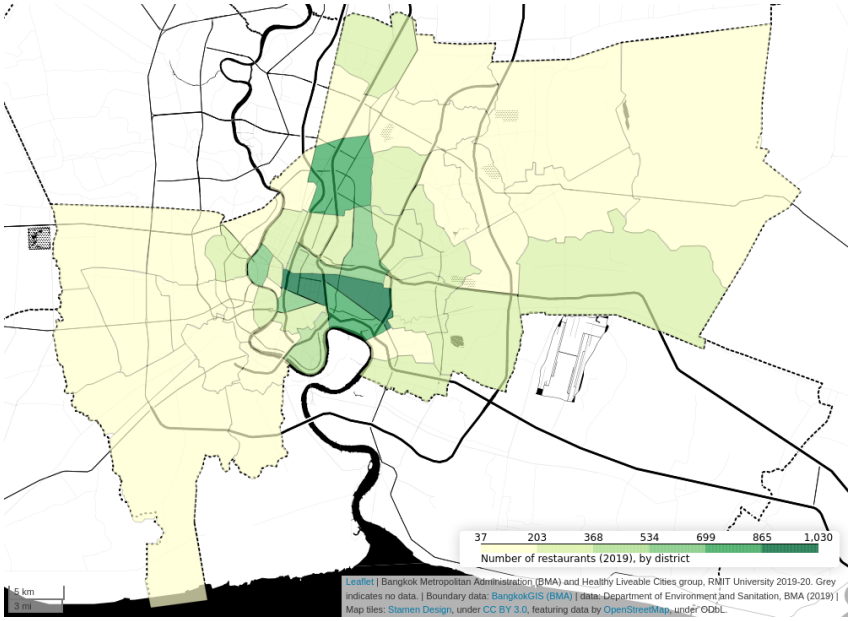


Fig. 304: Number of restaurants (2019), by district

Number of restaurants (2019) per km^2

The number of restaurants within each analysis area was recorded. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 11.

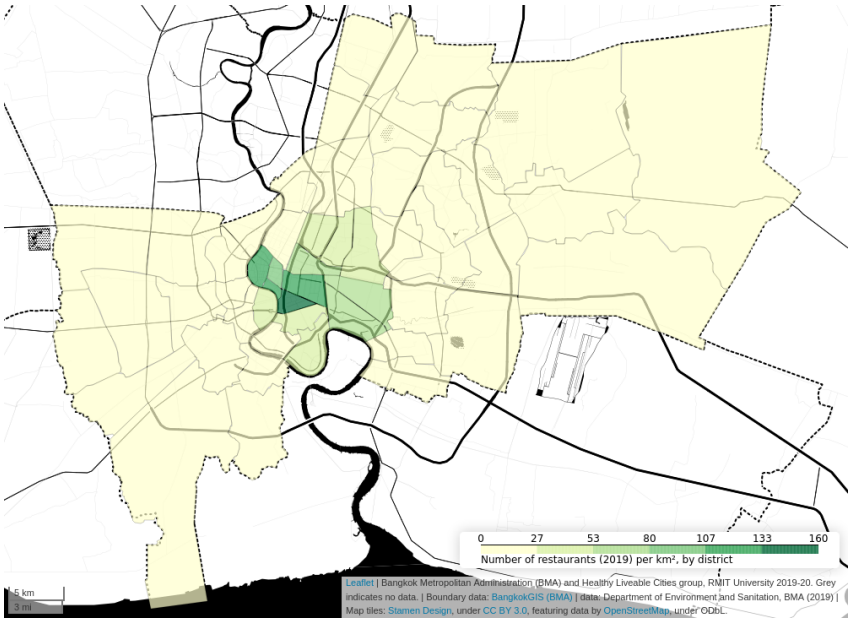


Fig. 305: Number of restaurants (2019) per km^2, by district

Number of restaurants (2019) per 10,000 population

The number of restaurants within each analysis area was recorded. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 11.

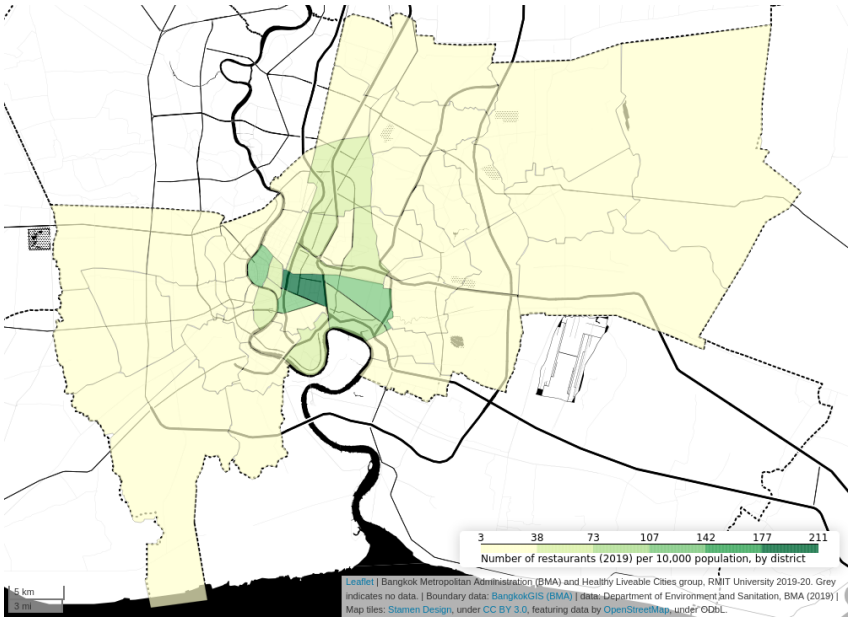


Fig. 306: Number of restaurants (2019) per 10,000 population, by district

Number of restaurants (2019) per 10,000 household

The number of restaurants within each analysis area was recorded. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 11.

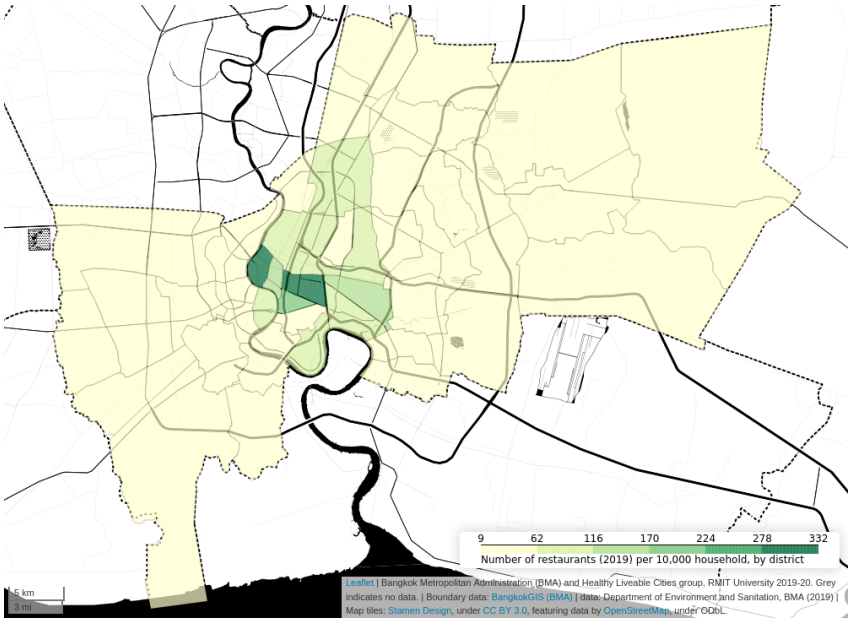


Fig. 307: Number of restaurants (2019) per 10,000 household, by district

Number of supermarkets (2019)

The number of supermarkets within each analysis area was recorded.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

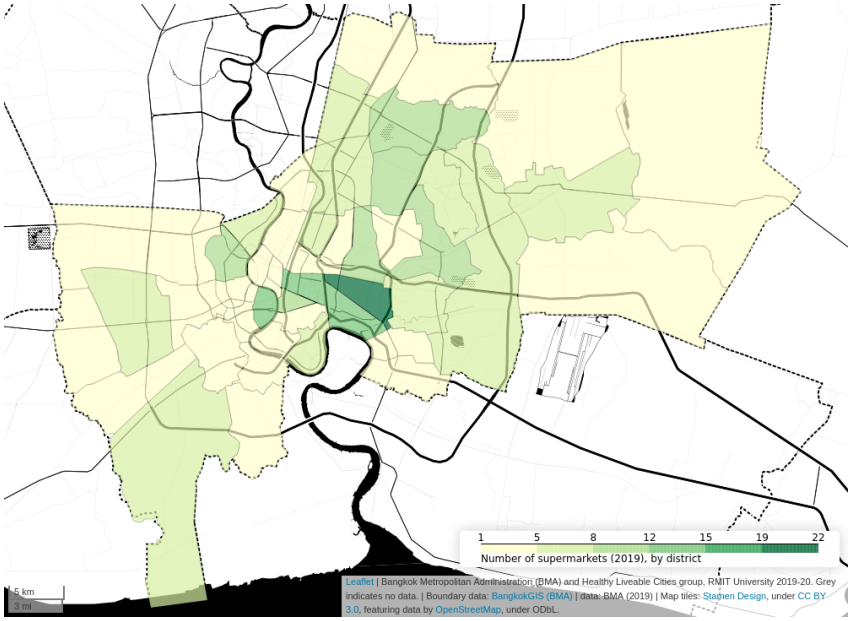


Fig. 308: Number of supermarkets (2019), by district

Number of supermarkets (2019) per km^2

The number of supermarkets within each analysis area was recorded. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

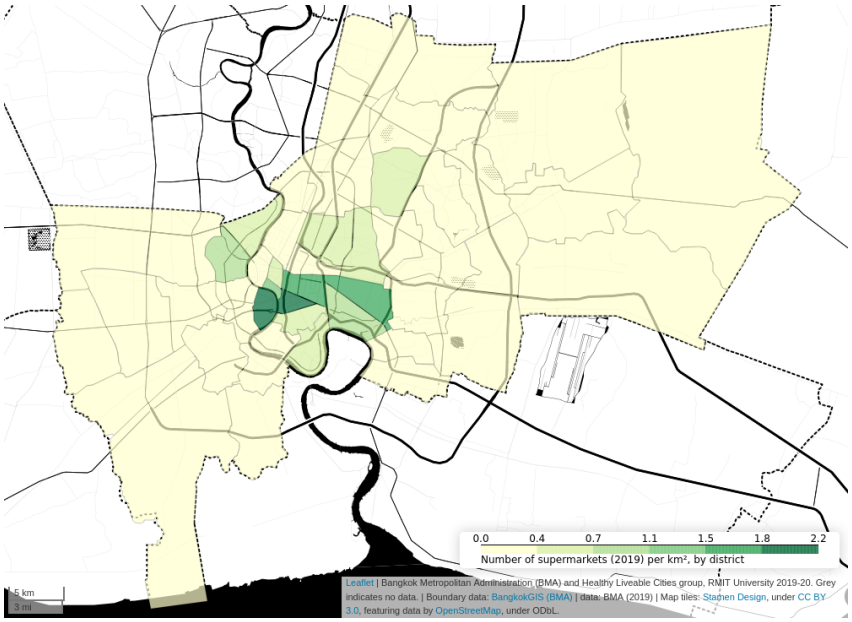


Fig. 309: Number of supermarkets (2019) per km^2, by district

Number of supermarkets (2019) per 10,000 population

The number of supermarkets within each analysis area was recorded. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

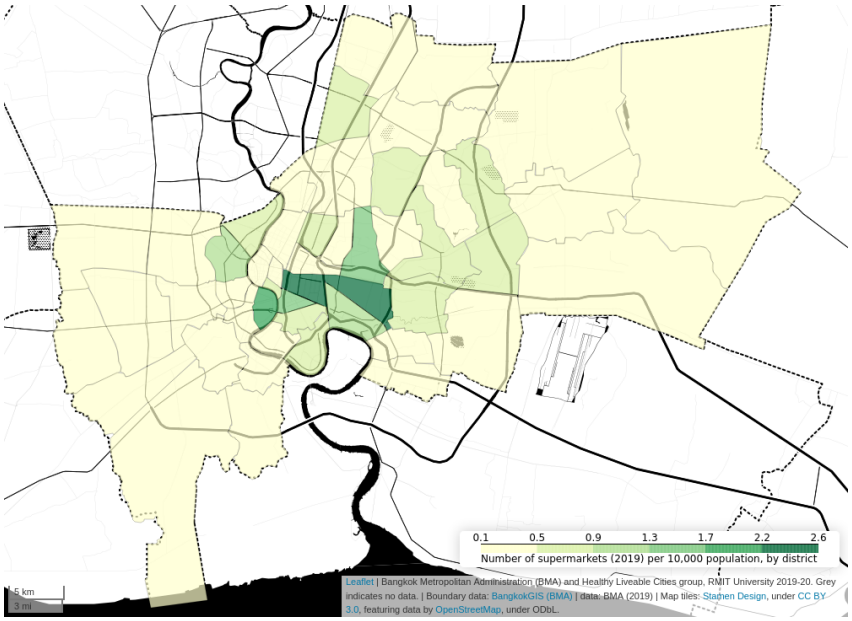


Fig. 310: Number of supermarkets (2019) per 10,000 population, by district

Number of supermarkets (2019) per 10,000 household

The number of supermarkets within each analysis area was recorded. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

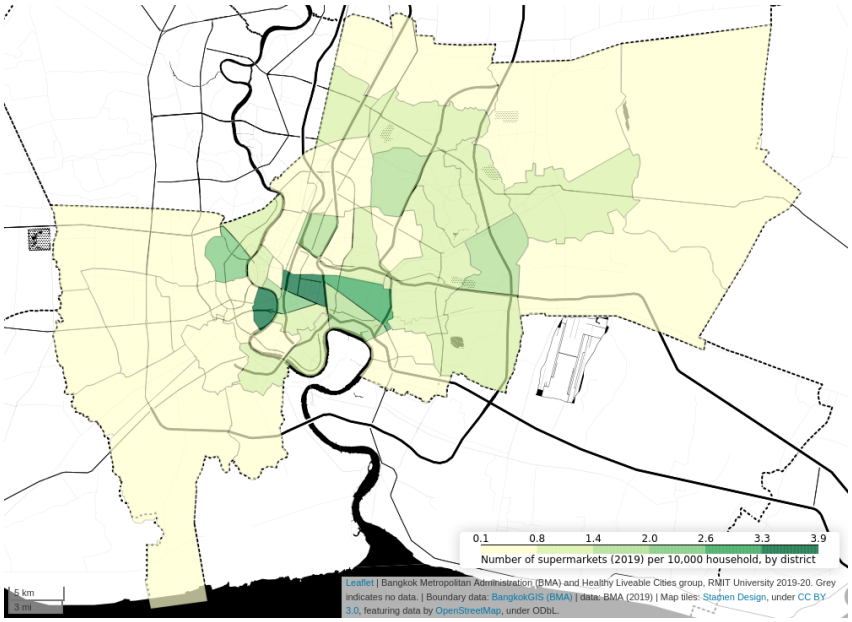


Fig. 311: Number of supermarkets (2019) per 10,000 household, by district

Number of minimarts (2019)

The number of minimarts within each analysis area was recorded.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

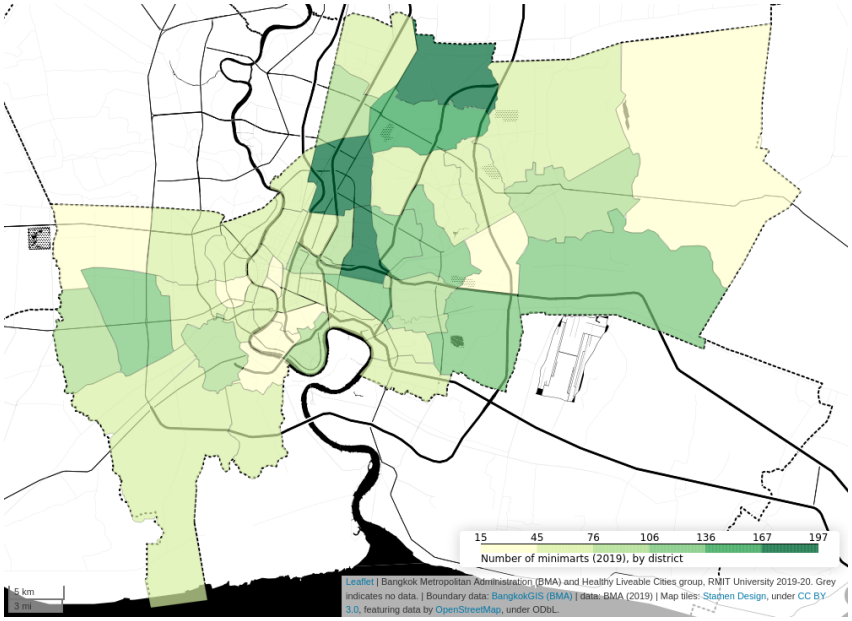


Fig. 312: Number of minimarts (2019), by district

Number of minimarts (2019) per km^2

The number of minimarts within each analysis area was recorded. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

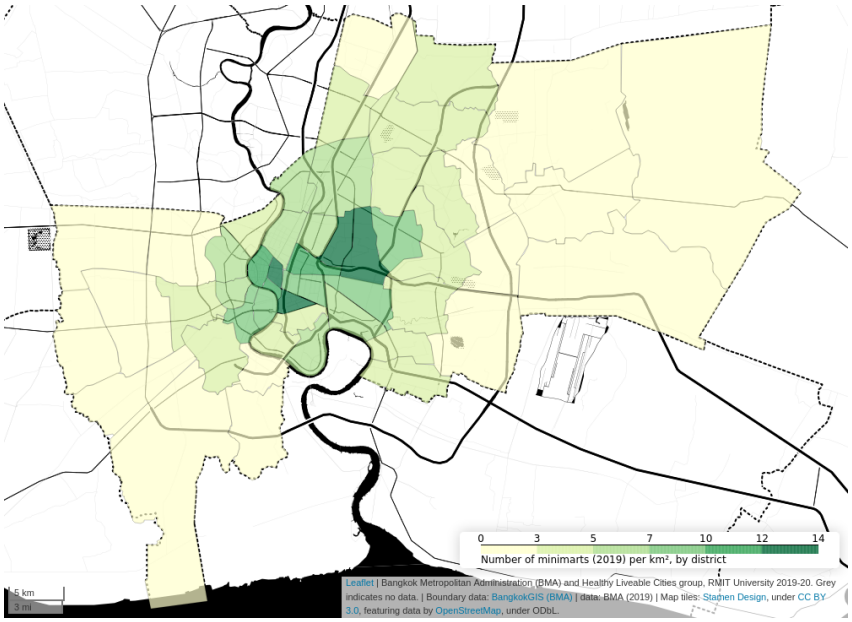


Fig. 313: Number of minimarts (2019) per km^2, by district

Number of minimarts (2019) per 10,000 population

The number of minimarts within each analysis area was recorded. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

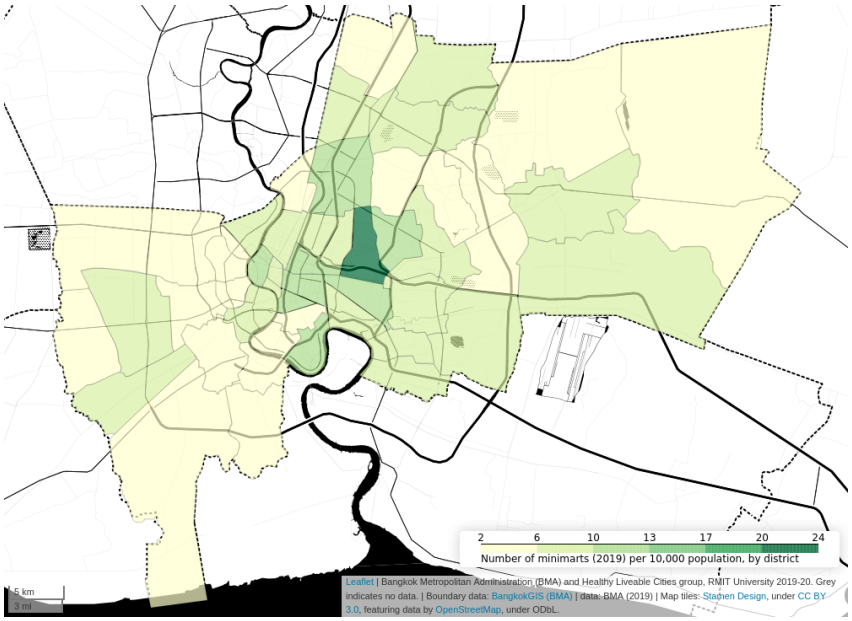


Fig. 314: Number of minimarts (2019) per 10,000 population, by district

Number of minimarts (2019) per 10,000 household

The number of minimarts within each analysis area was recorded. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

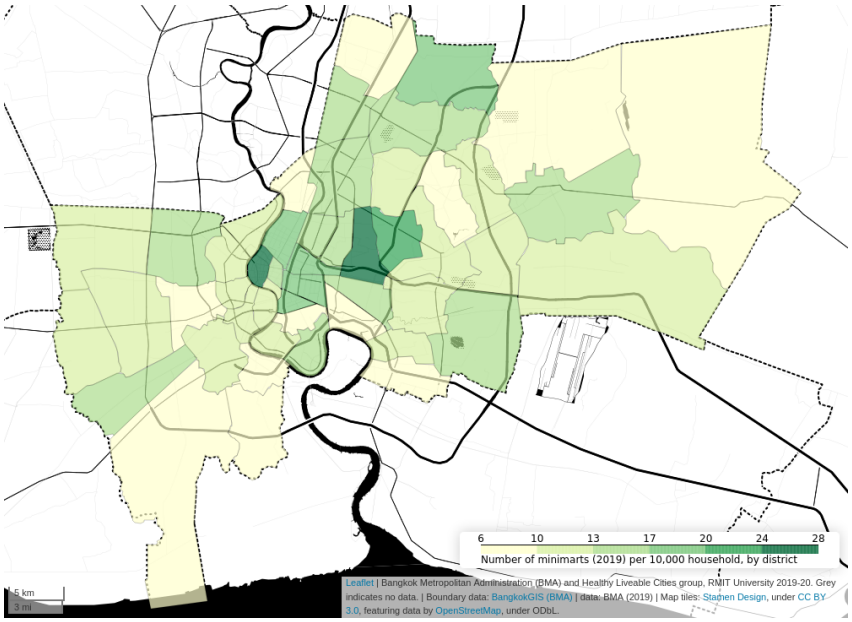


Fig. 315: Number of minimarts (2019) per 10,000 household, by district

Number of stalls (2019)

The number of stalls within each analysis area was recorded.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

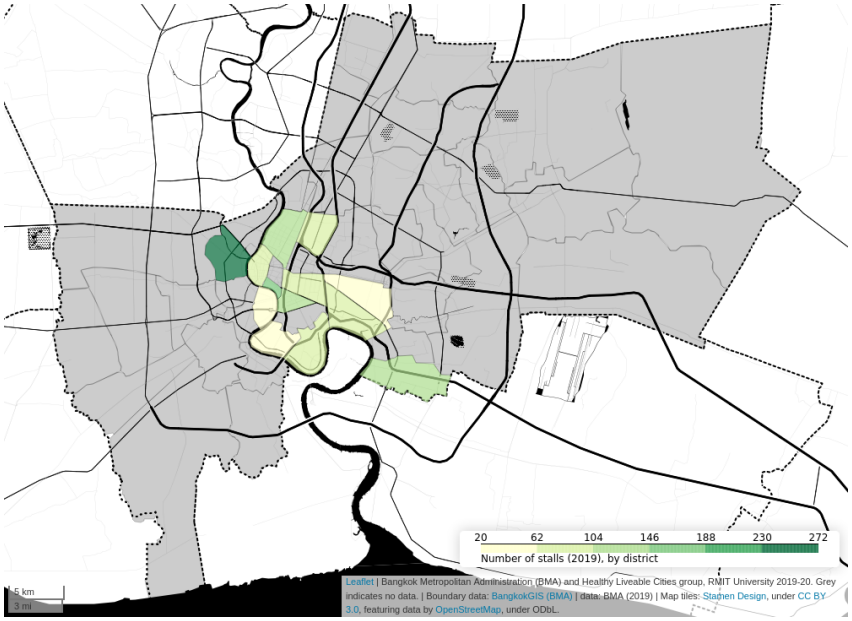


Fig. 316: Number of stalls (2019), by district

Number of stalls (2019) per km^2

The number of stalls within each analysis area was recorded. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

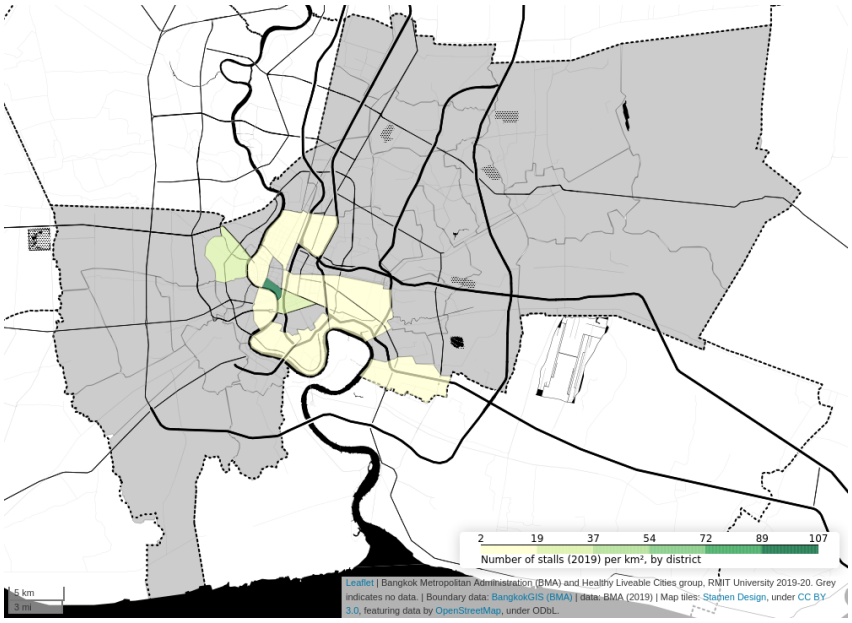


Fig. 317: Number of stalls (2019) per km^2, by district

Number of stalls (2019) per 10,000 population

The number of stalls within each analysis area was recorded. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

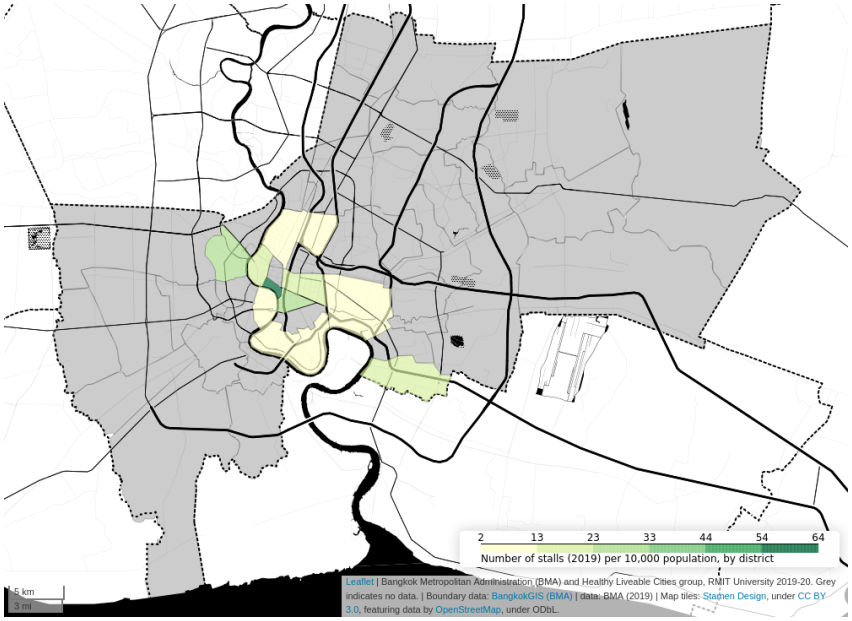


Fig. 318: Number of stalls (2019) per 10,000 population, by district

Number of stalls (2019) per 10,000 household

The number of stalls within each analysis area was recorded. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

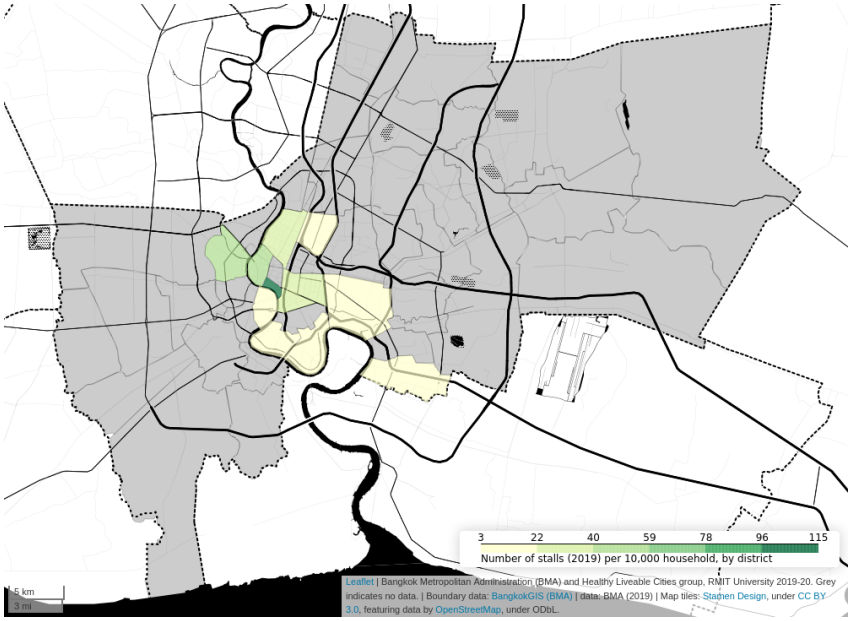


Fig. 319: Number of stalls (2019) per 10,000 household, by district

Number of markets (2019)

The number of markets within each analysis area was recorded.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

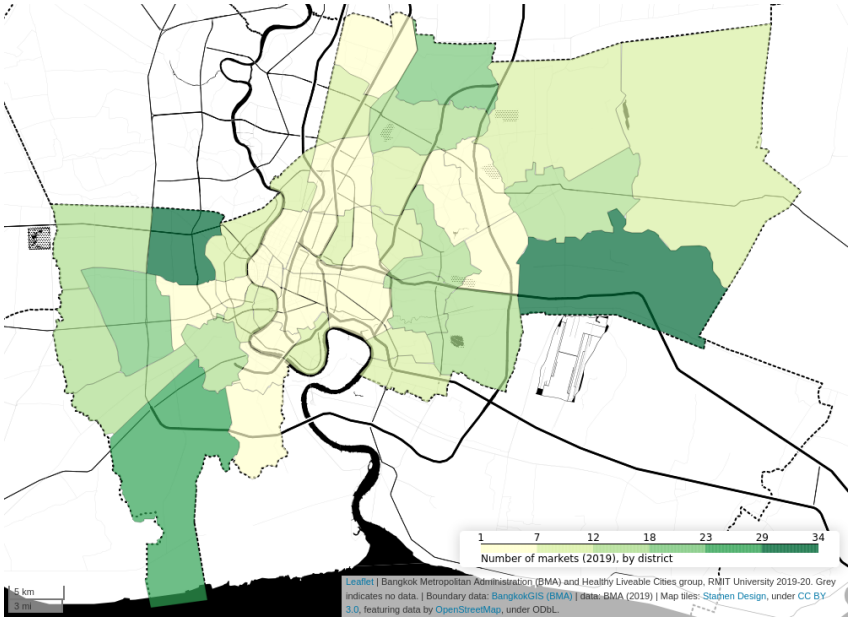


Fig. 320: Number of markets (2019), by district

Number of markets (2019) per km²

The number of markets within each analysis area was recorded. The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

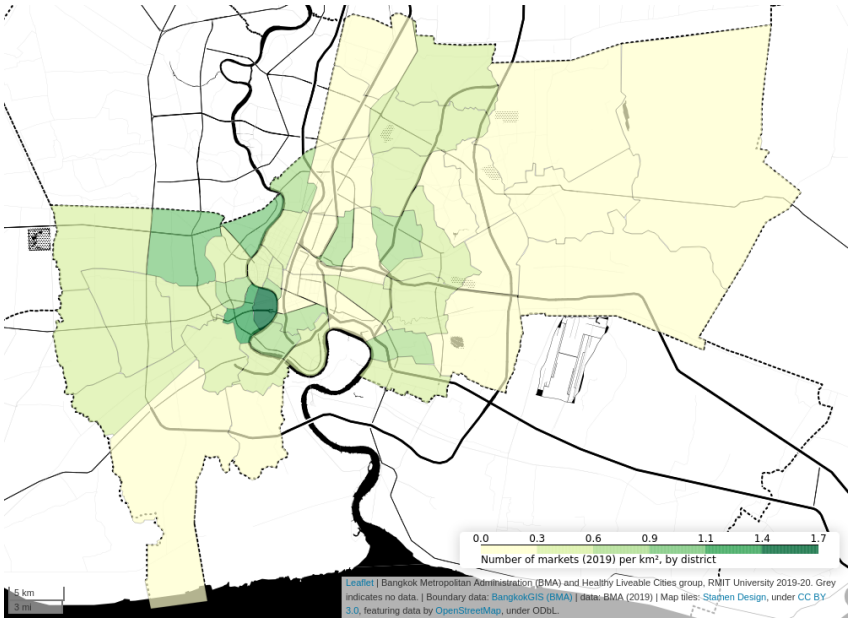


Fig. 321: Number of markets (2019) per km^2, by district

Number of markets (2019) per 10,000 population

The number of markets within each analysis area was recorded. The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

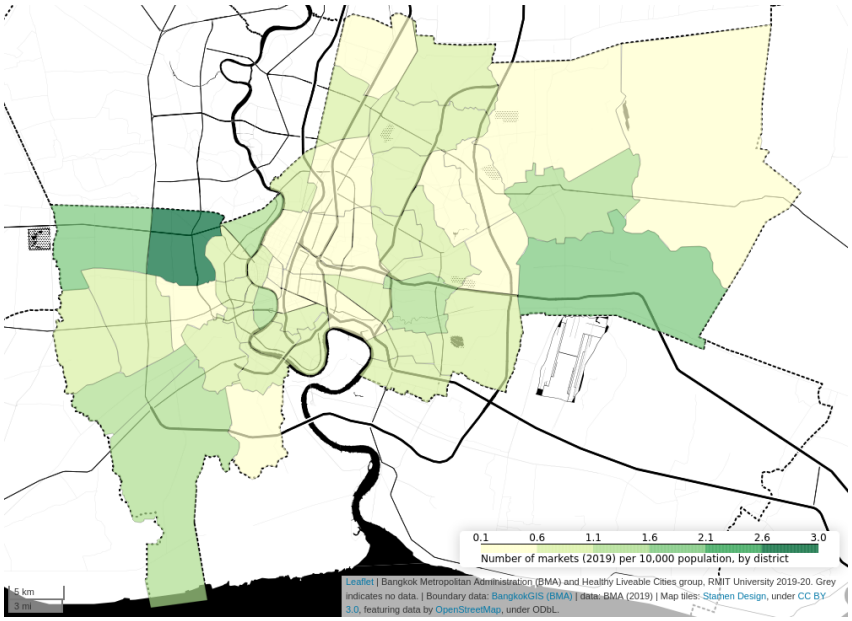


Fig. 322: Number of markets (2019) per 10,000 population, by district

Number of markets (2019) per 10,000 household

The number of markets within each analysis area was recorded. The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

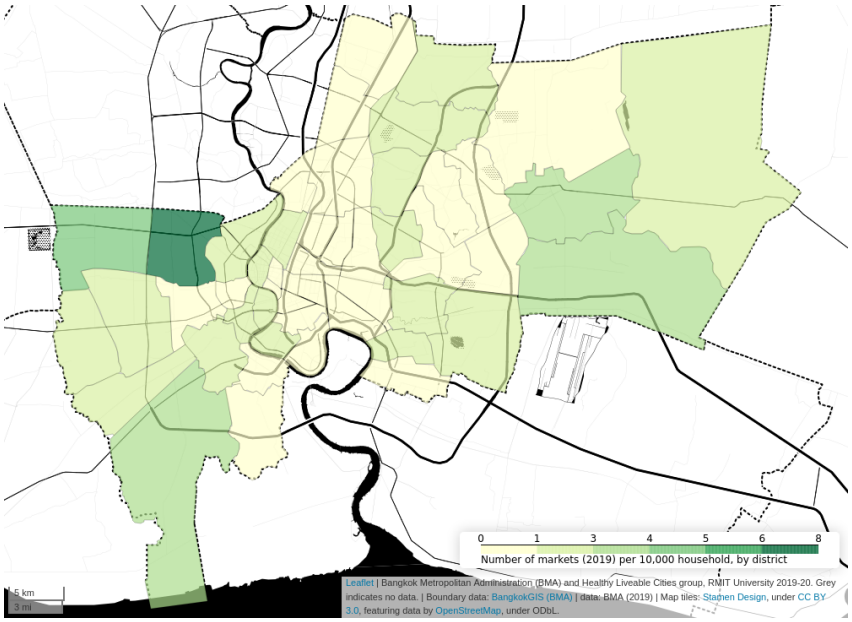


Fig. 323: Number of markets (2019) per 10,000 household, by district

Dataset: Sidewalk hawkers

Data comprising counts of permitted sidewalk locations for hawkers/stalls, and the number of hawkers and stalls for each district were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. Data were cleaned for processing and aligned with area IDs.

Data source: `Department of City Law Enforcement, BMA`

Publication year: `2019`

Target year: `2019`

Acquisition date (yyyymmdd): `20191204`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20191204/transfer_1815197_files_51cc5a2c/3_BKK_sidewalk_hawkers - stalls _2019 _kn20190923.xlsx`

Permitted sidewalk hawker/stall locations (2019)

The number of permitted sidewalk points for hawker/stall locations was recorded

Aligns with Sustainable Development Goals: 2.1, 3, 11.

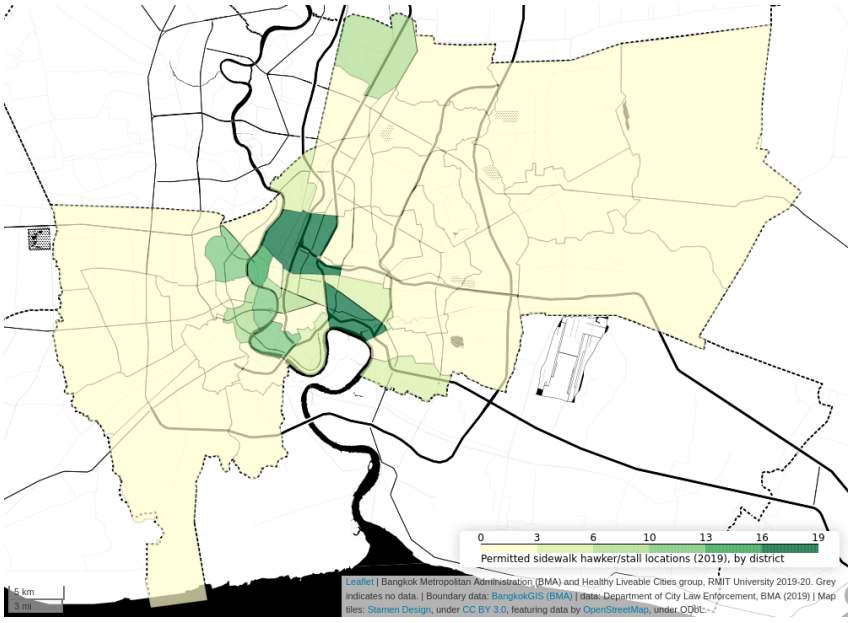


Fig. 324: Permitted sidewalk hawker/stall locations (2019), by district

Permitted sidewalk hawker/stall locations (2019) per km²

The number of permitted sidewalk points for hawker/stall locations was recorded The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

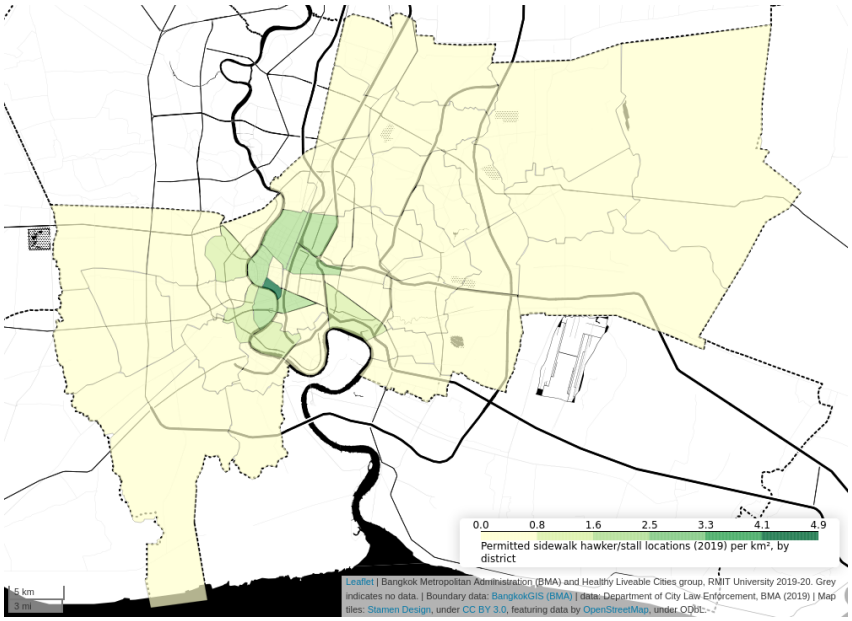


Fig. 325: Permitted sidewalk hawker/stall locations (2019) per km^2, by district

Permitted sidewalk hawker/stall locations (2019) per 10,000 population

The number of permitted sidewalk points for hawker/stall locations was recorded The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

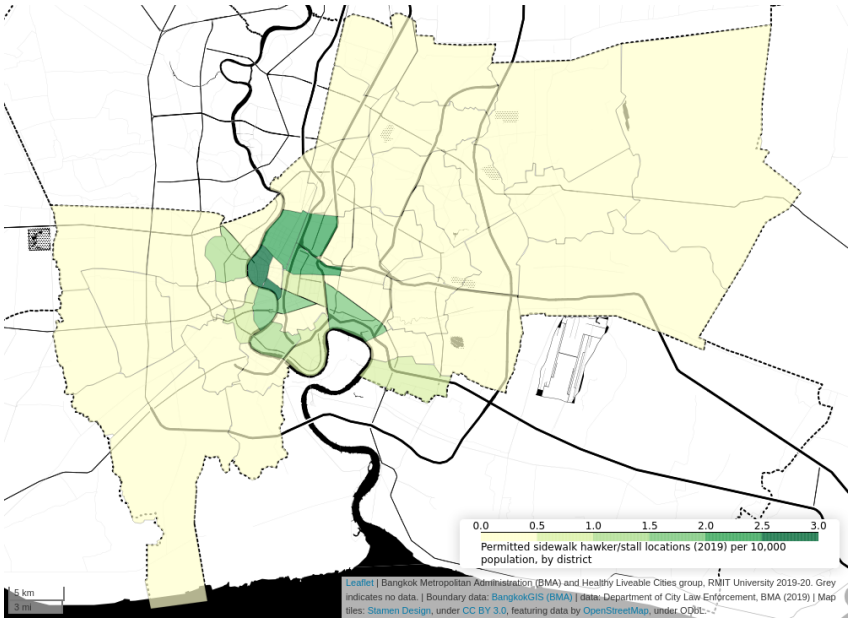


Fig. 326: Permitted sidewalk hawker/stall locations (2019) per 10,000 population, by district

Permitted sidewalk hawker/stall locations (2019) per 10,000 household

The number of permitted sidewalk points for hawker/stall locations was recorded The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

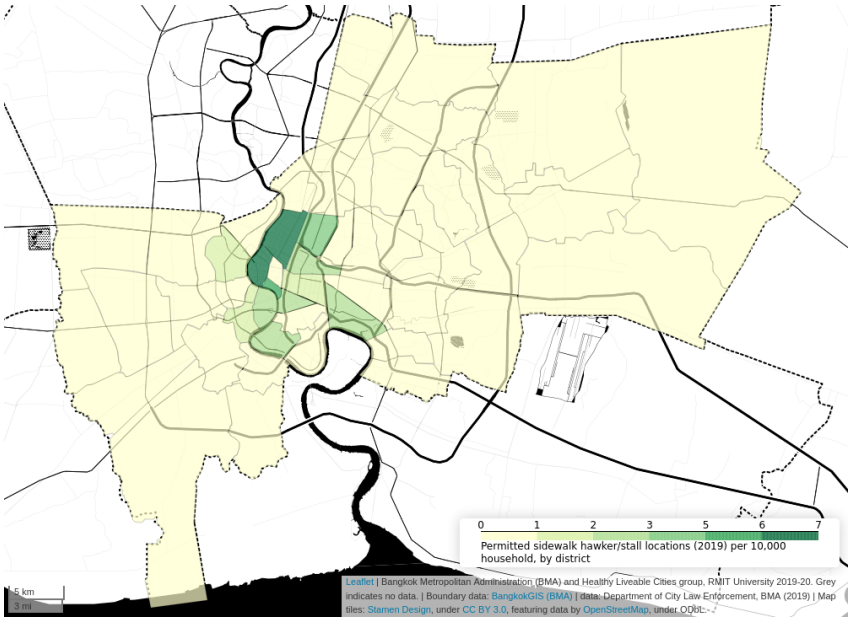


Fig. 327: Permitted sidewalk hawker/stall locations (2019) per 10,000 household, by district

Dataset: Food quality tests

Data on food quality testing across 50 Bangkok districts between October 2018 to July 2019 were acquired from the BMA Health Department. The data was comprised of spreadsheets detailing the number of food establishments, and for each of 9 key quality stanards, the number of tests conducted and the number of tests which did not pass: การตรวจด้านกายภาพ Physical examination; ฟอร์มาลิน formalin; สารฟอกขาว Bleach; สารกันรา Mold; ยาฆ่าแมลง Insecticide; สีสังเคราะห์ Synthetic color; สารโพลาร์ Polar substance; กรดแร่อิสระ Free mineral acid; and ไอโอเดท Iodate.

Data source: `Health Department BMA`

Publication year: `2019`

Target year: `2019`

Acquisition date (yyyymmdd): `20191204`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20191204/transfer_1815206_files_409fa2da/BKK_ Food quality testing_2018_19_kn20191114.xlsx`

Food quality tests (2019)

The total number of tests conducted across all 9 health and hygeine standards in each district were summed. Not all tests were conducted in all districts, and some had low sampling; for example, Wang Thonglang (481 establishments) had zero samples taken for two tests (synthetic color, and free mineral acid), and Khan Na Yao (281 establishments) had only 1 sample recorded for insecticide. On the other hand, some other districts had a high ratio of tests to establishments. This data context is important to remember when interpreting the data (for example, out of 1/1592 samples in Chatuchak did not pass insecticide quality standard testing, and so for this standard the target of 100% was not achieved; the comparison with Khan Na Yao where 1/1 tests passed does not in itself provide a fair comparison for food quality in the two districts).

Aligns with Sustainable Development Goals: 2.1, 3, 11.

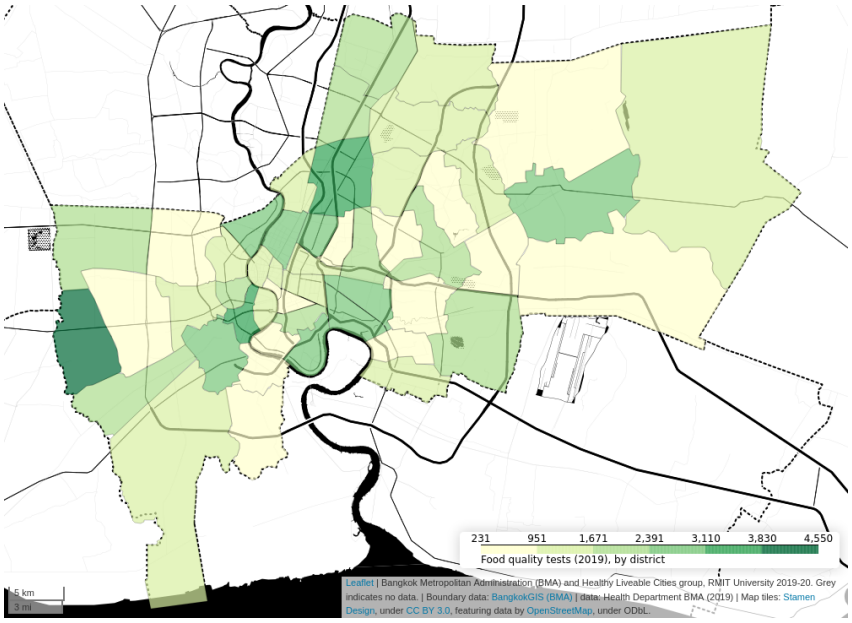


Fig. 328: Food quality tests (2019), by district

Food quality tests (2019) per km^2

The total number of tests conducted across all 9 health and hygeine standards in each district were summed. Not all tests were conducted in all districts, and some had low sampling; for example, Wang Thonglang (481 establishments) had zero samples taken for two tests (synthetic color, and free mineral acid), and Khan Na Yao (281 establishments) had only 1 sample recorded for insecticide. On the other hand, some other districts had a high ratio of tests to establishments. This data context is important to remember when interpreting the data (for example, out of 1/1592 samples in Chatuchak did not pass insecticide quality standard testing, and so for this standard the target of 100% was not achieved; the comparison with Khan Na Yao where 1/1 tests passed does not in itself provide a fair comparison for food quality in the two districts). The indicator was rated as the rate per km^2.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

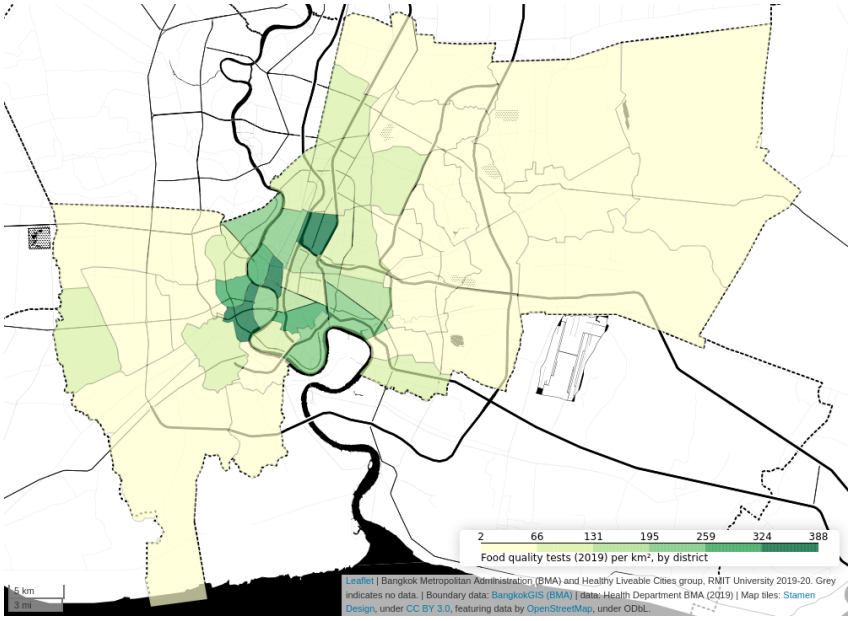


Fig. 329: Food quality tests (2019) per km^2, by district

Food quality tests (2019) per 10,000 population

The total number of tests conducted across all 9 health and hygeine standards in each district were summed. Not all tests were conducted in all districts, and some had low sampling; for example, Wang Thonglang (481 establishments) had zero samples taken for two tests (synthetic color, and free mineral acid), and Khan Na Yao (281 establishments) had only 1 sample recorded for insecticide. On the other hand, some other districts had a high ratio of tests to establishments. This data context is important to remember when interpreting the data (for example, out of 1/1592 samples in Chatuchak did not pass insecticide quality standard testing, and so for this standard the target of 100% was not achieved; the comparison with Khan Na Yao where 1/1 tests passed does not in itself provide a fair comparison for food quality in the two districts). The indicator was rated as the rate per 10,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

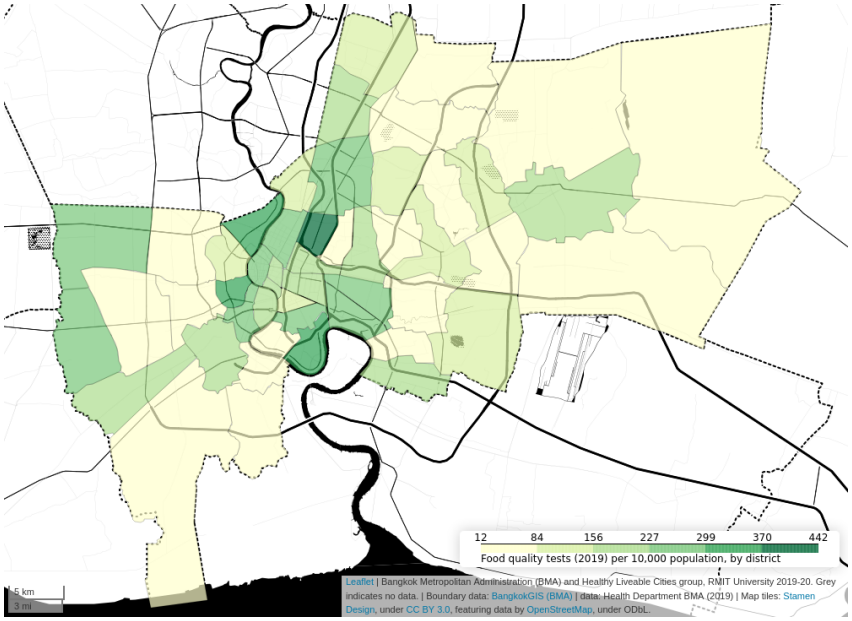


Fig. 330: Food quality tests (2019) per 10,000 population, by district

Food quality tests (2019) per 10,000 household

The total number of tests conducted across all 9 health and hygeine standards in each district were summed. Not all tests were conducted in all districts, and some had low sampling; for example, Wang Thonglang (481 establishments) had zero samples taken for two tests (synthetic color, and free mineral acid), and Khan Na Yao (281 establishments) had only 1 sample recorded for insecticide. On the other hand, some other districts had a high ratio of tests to establishments. This data context is important to remember when interpreting the data (for example, out of 1/1592 samples in Chatuchak did not pass insecticide quality standard testing, and so for this standard the target of 100% was not achieved; the comparison with Khan Na Yao where 1/1 tests passed does not in itself provide a fair comparison for food quality in the two districts). The indicator was rated as the rate per 10,000 household.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

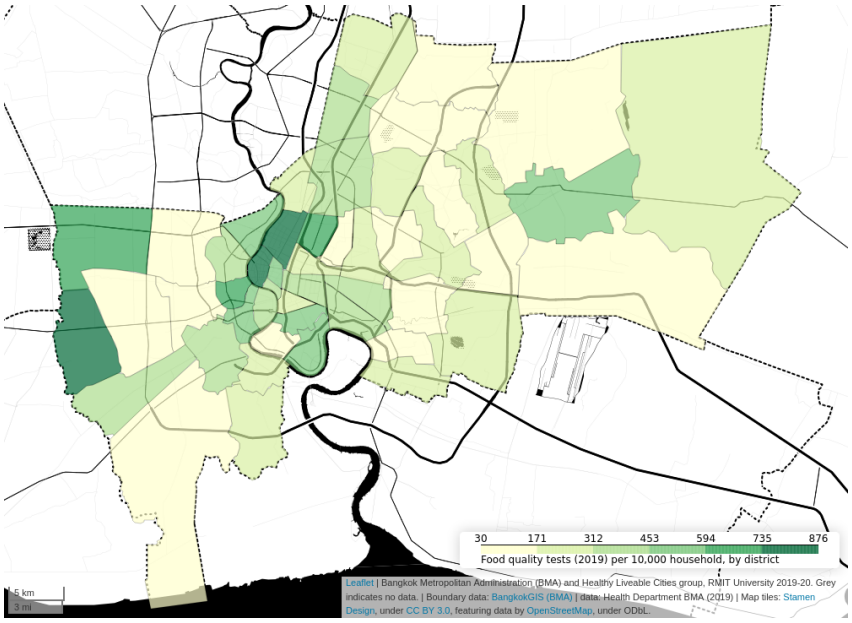


Fig. 331: Food quality tests (2019) per 10,000 household, by district

Percentage of food standards (/9) with 100% test pass rate (2019)

Percentage of food health and hygiene standards (/9) with 100% of samples passing quality testing was recorded.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

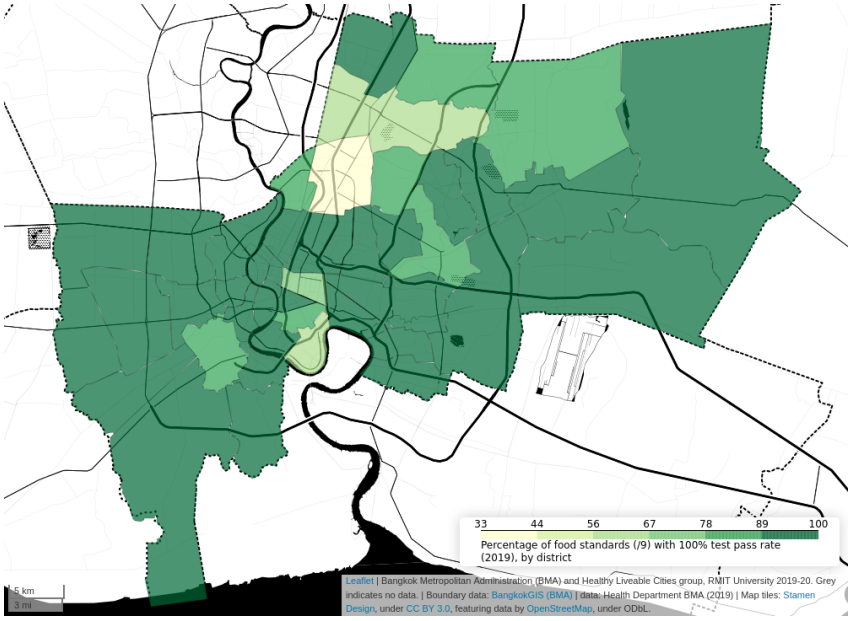


Fig. 332: Percentage of food standards (/9) with 100% test pass rate (2019), by district

2.5.4 High quality education and schools

โรงเรียนและการศึกษาที่มีคุณภาพสูง

Good quality education means that all learners learn the value of humanity, have the knowledge needed to make an impact in improving the quality of life and well-being of each individual, as well as participating in sustainable social and economic development. Important basic education encompasses an acceptable level of literacy and numeracy, basic scientific knowledge as well as life skills, including awareness and disease prevention. Note: the secondary schools are not under the BMA's responsibility.

Dataset: BMA School locations

Data on locations of BMA primary schools (2016) was cleaned, such that it represented counts by subdistrict, and associated with district and subdistrict area linkage identifiers

Data source: `Education Department, BMA`

Publication year: `2019`

Target year: `2016`

Acquisition date (yyyymmdd): `20191204`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20191204/transfer_1815206_files_409fa2da/V3_BMA schools _location_subdistrict_kn 20191203.xlsx`

Number of primary schools (2016)

The total count of BMA primary schools was calculated for each district and subdistrict. District estimates were derived by summing the subdistrict counts. Primary school counts were considered relative to area population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

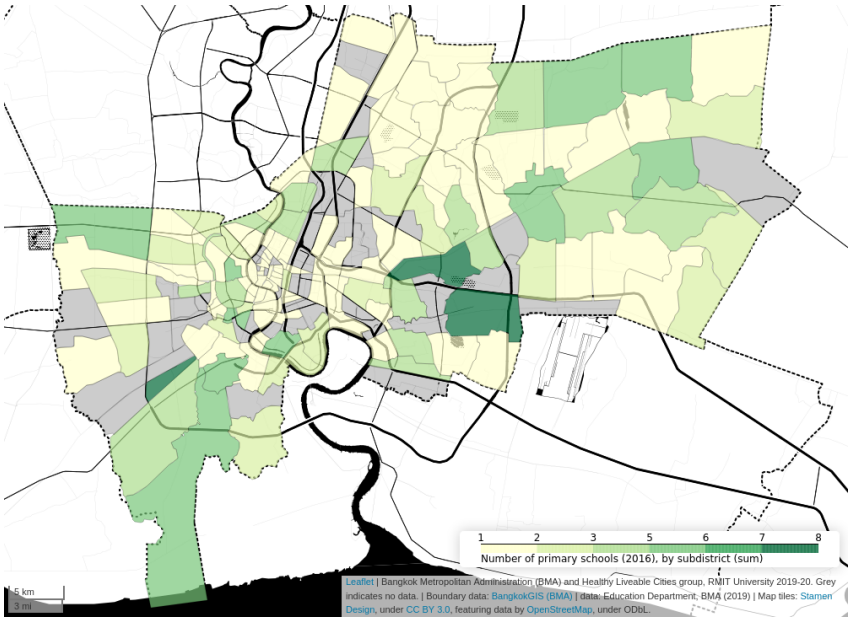


Fig. 333: Number of primary schools (2016), by subdistrict

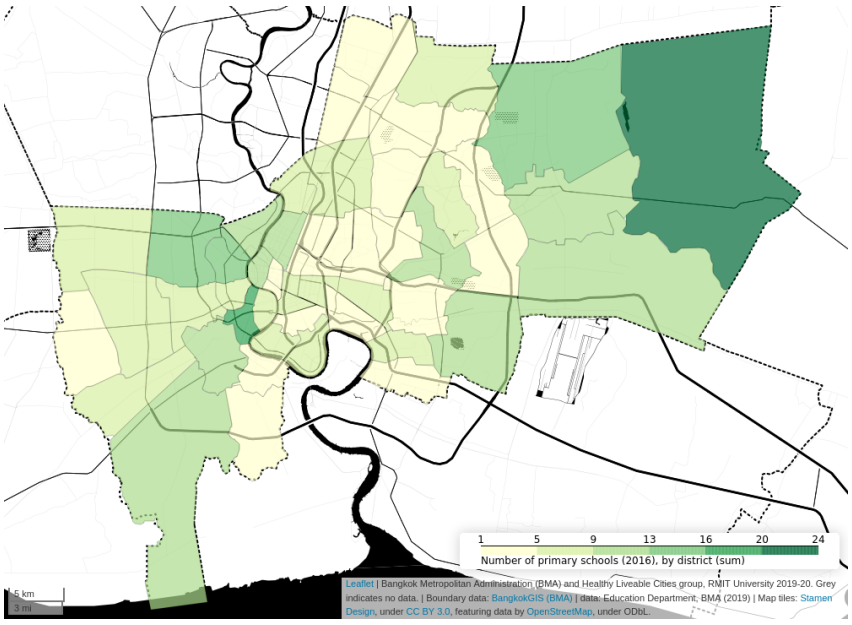


Fig. 334: Number of primary schools (2016), by district

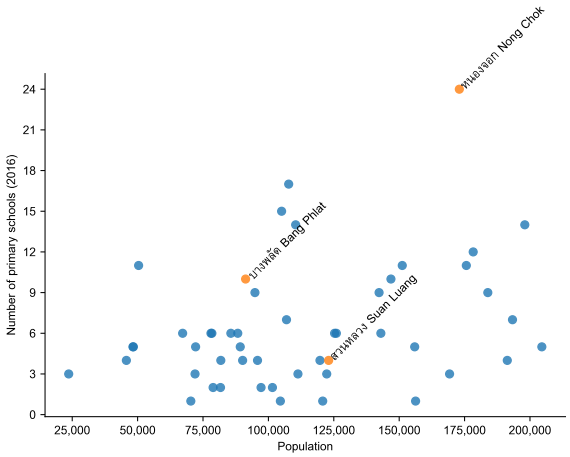


Fig. 335: Scatterplot of primary schools by population for districts.

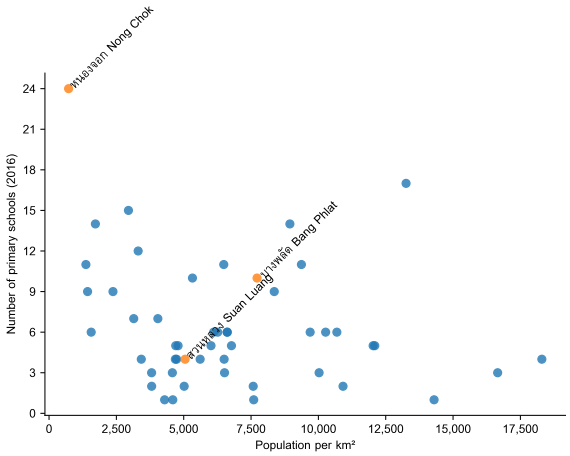


Fig. 336: Scatterplot of primary schools by population density for districts.

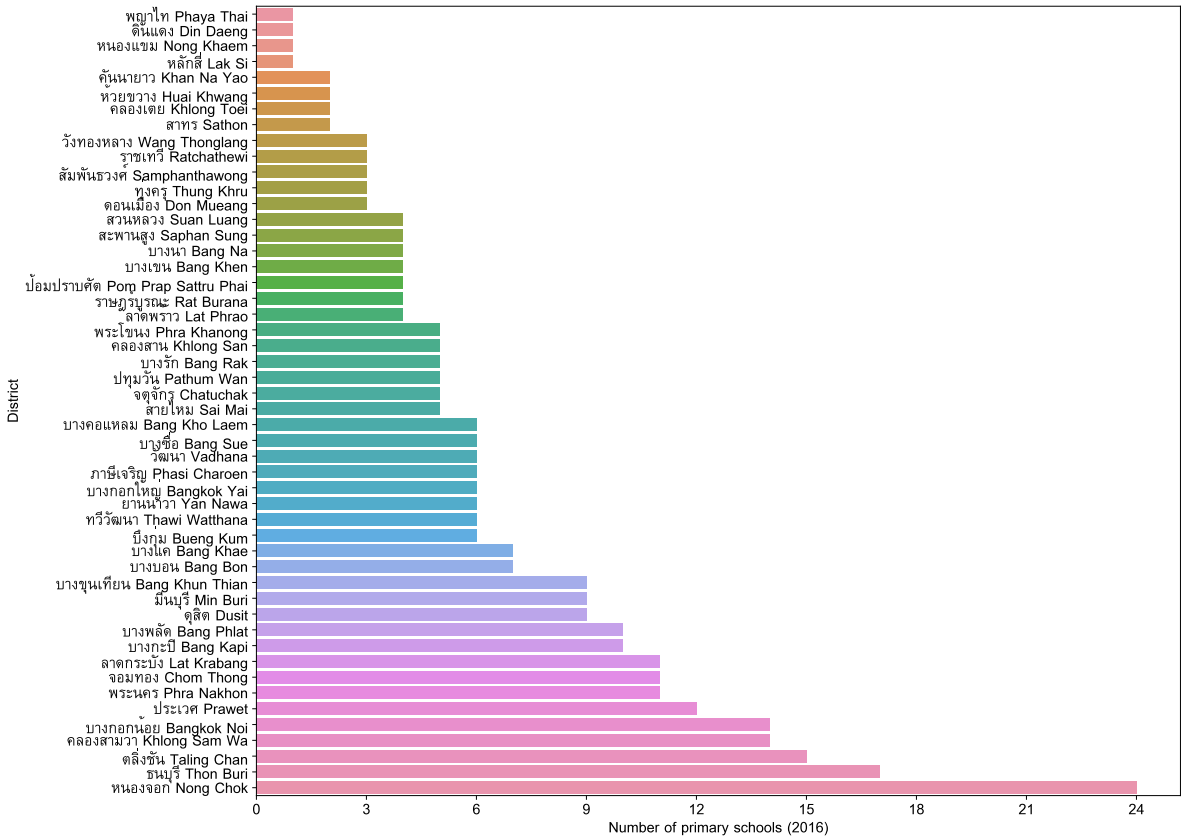


Fig. 337: Districts ranked in ascending order by primary schools with regard to number of primary schools (2016).

Number of primary schools (2016) per 1,000 population

The total count of BMA primary schools was calculated for each district and subdistrict. District estimates were derived by summing the subdistrict counts. Primary school counts were considered relative to area population. The indicator was rated as the rate per 1,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

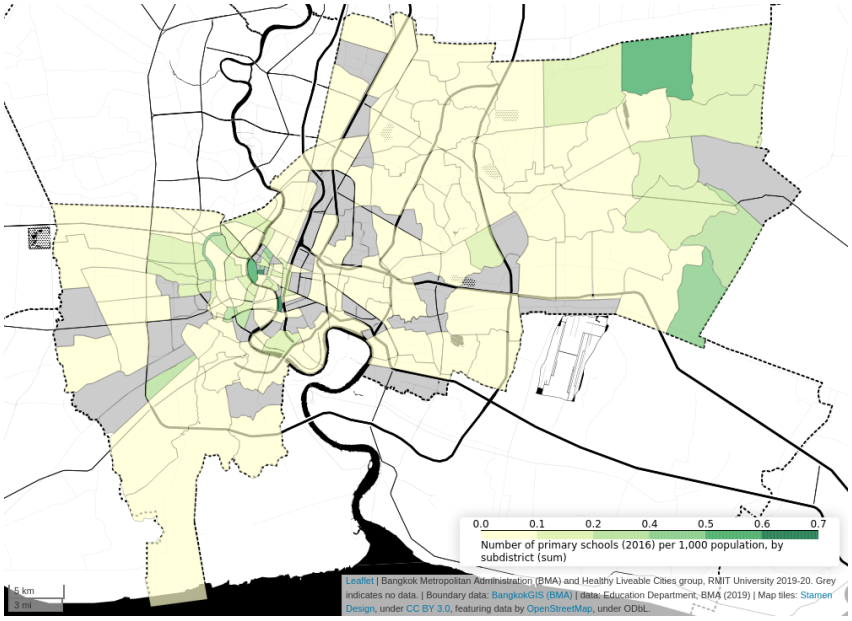


Fig. 338: Number of primary schools (2016) per 1,000 population, by subdistrict

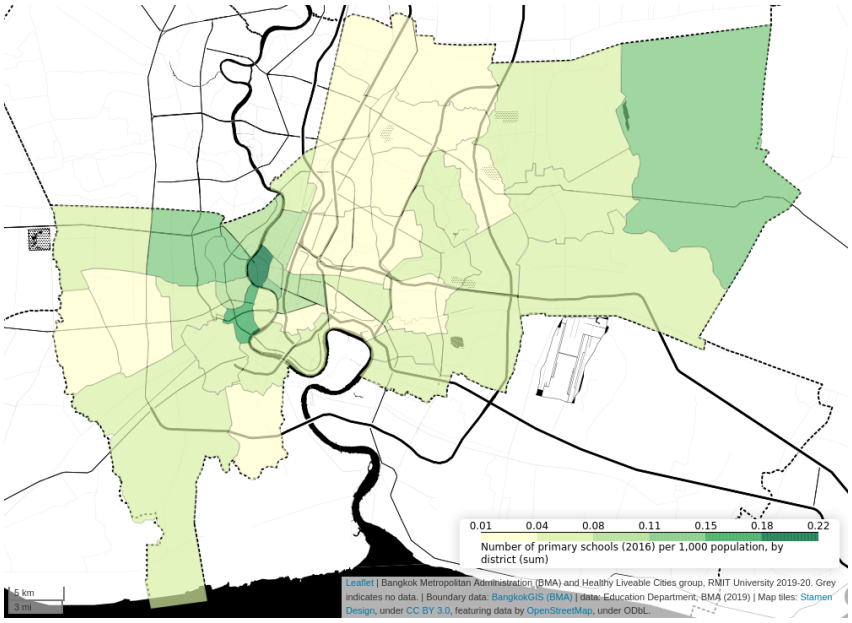


Fig. 339: Number of primary schools (2016) per 1,000 population, by district

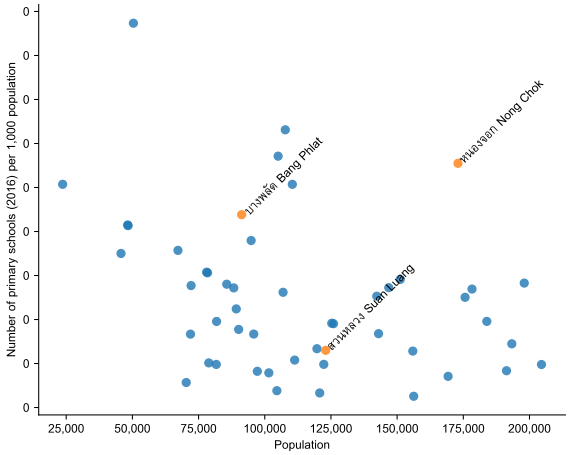


Fig. 340: Scatterplot of primary schools by population for districts.

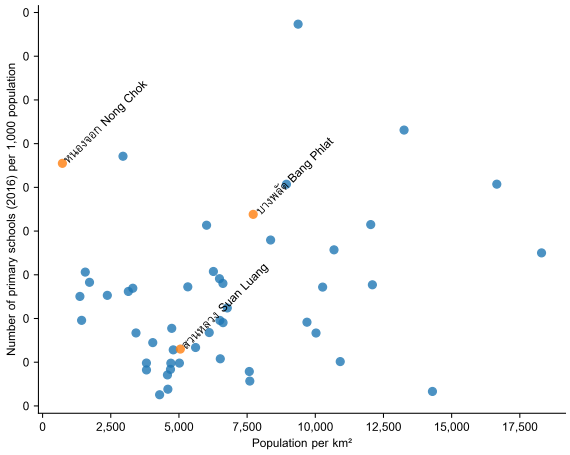


Fig. 341: Scatterplot of primary schools by population density for districts.

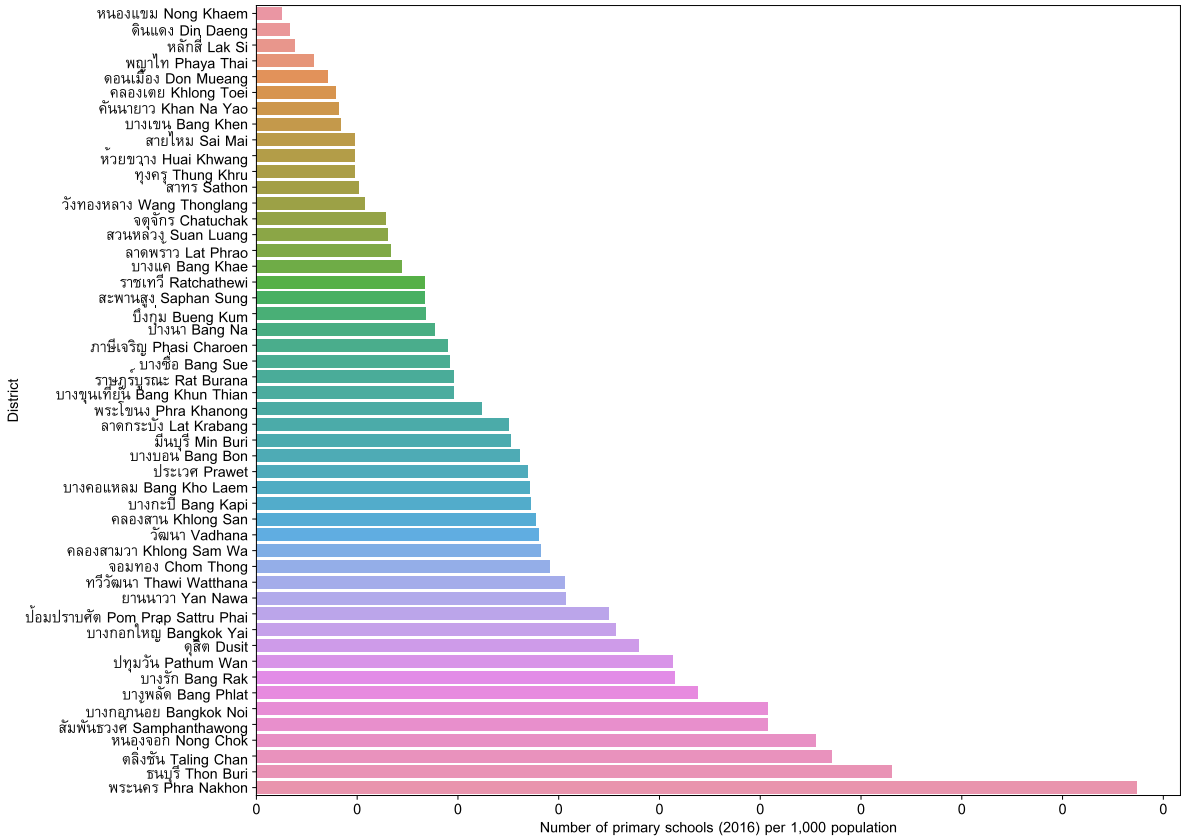


Fig. 342: Districts ranked in ascending order by primary schools with regard to number of primary schools (2016) per 1,000 population.

Dataset: O-Net in BMA schools

Data on the district average score of the test results of the National General Education (O-NET) for level 6 primary school students across four core subjects (Thai, mathematics, science and English) was cleaned and associated with area linkage codes.

Data source: `Education Department, BMA`

Publication year: `2019`

Target year: `2016`

Acquisition date (yyyymmdd): `20200511`

Licence: `none specified`

Date type: `numeric`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20200511/O-NET in BMA schools Academic year 2018 __ only primalt level 6 _kn20200508.xlsx`

Average National General Education (O-NET) score for BMA primary schools for each of four core subjects (Thai, mathematics, science and English; 2016)

The average across all four core subject scores for each district was taken, for evaluation against a target (for individual subjects) of > 50. There were no districts achieving an average score of greater than 50 in each subject, so the average of the four subjects in each district was taken as an alternative continuous indicator. Only Chatuchak (6 schools) achieved an overall average of greater than 50. However, it should be noted that district averages do not necessarily reflect individual school performance (some districts have more than 20 schools), and within schools it is expected that there may be considerable heterogeneity. Furthermore, estimates of the average score may be influenced by poor performing outlying students, and alternate measures such as the median may be more appropriate as a summary of central tendency. As such, it is recommended that these results be interpreted cautiously, with consideration to reviewing the distribution of student results as clustered within schools and districts in more depth.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

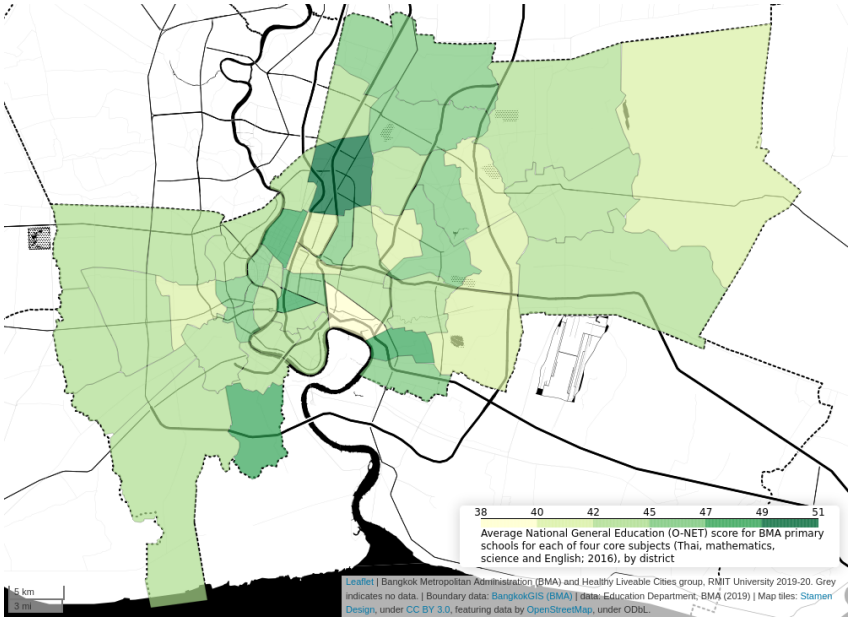


Fig. 343: Average National General Education (O-NET) score for BMA primary schools for each of four core subjects (Thai, mathematics, science and English; 2016), by district

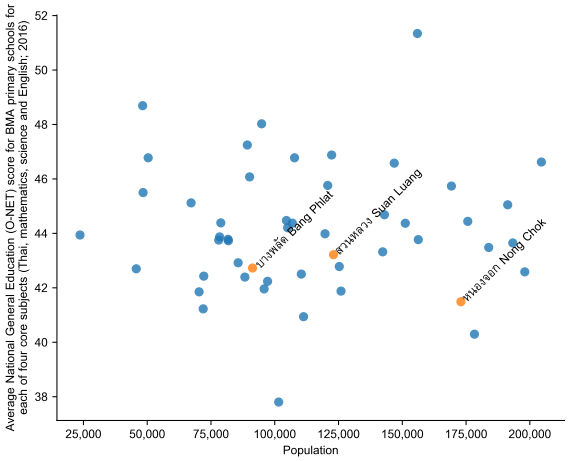


Fig. 344: Scatterplot of average O-NET by population for districts.

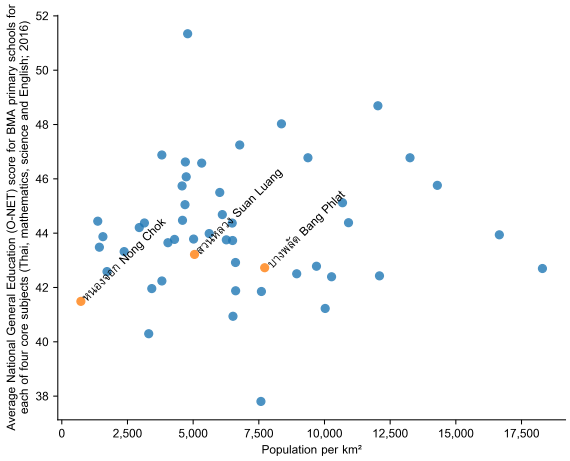


Fig. 345: Scatterplot of average O-NET by population density for districts.

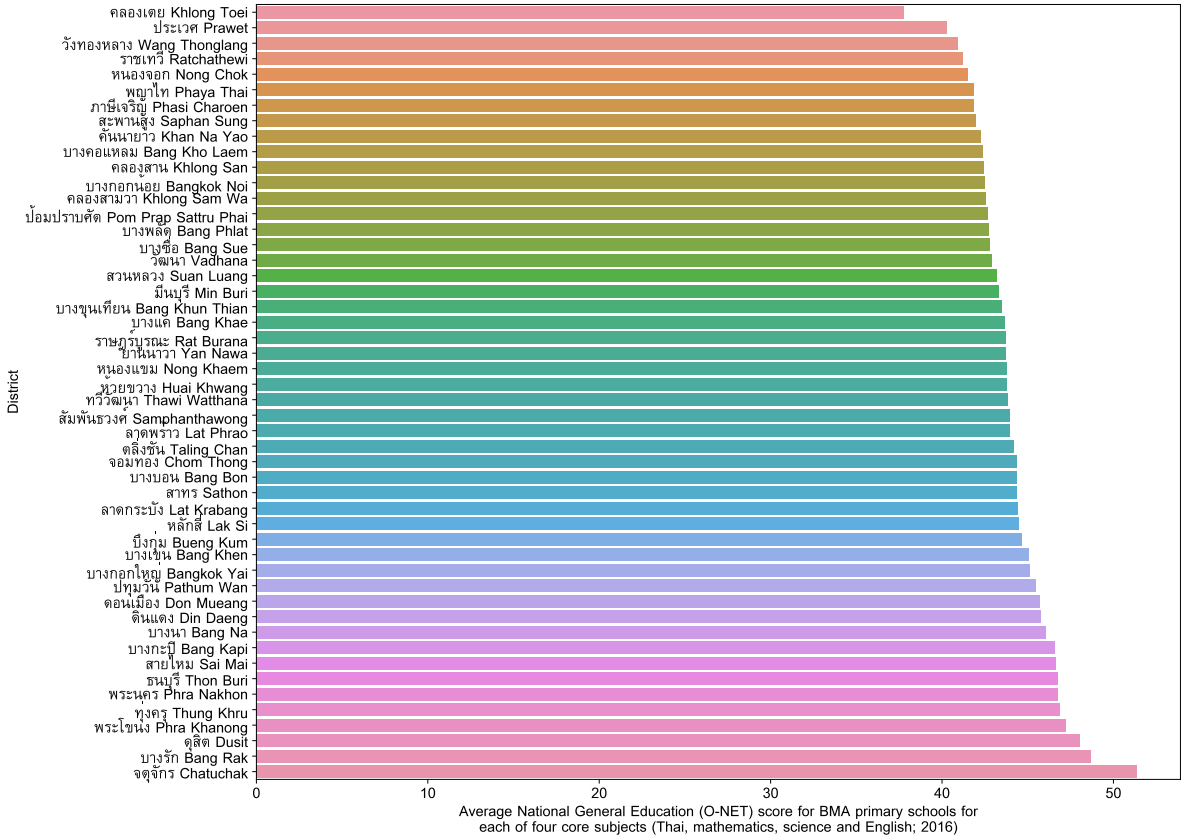


Fig. 346: Districts ranked in ascending order by average o-net with regard to average national general education (o-net) score for bma primary schools for each of four core subjects (thai, mathematics, science and english; 2016).

2.5.5 Access to temples, museums, music and other cultural events that provide opportunities for people to come together; Multi-purpose local community centres

การเข้าถึงวัด พิพิธภัณฑ์ การจัดงานด้านวัฒนธรรมและดนตรีที่เปิดโอกาสให้ประชาชนมารวมกัน ศูนย์ชุมชนที่ดำเนินการด้วยวัตถุประสงค์หลากหลาย

Access to cultural facilities means that people have access to various locations for increasing their happiness and promoting good actions. Such places or facilities include religious sites, museums, theaters, arts and craft centers, theatre, as well as cultural and music events in communities or neighborhoods.

Dataset: BMA Places of Worship

Data on counts of places of worship (Temples; Mosques; Christian, Hindu and Sikh churches; and Shrines) were cleaned and associated with area linkage codes.

Data source: `Buddhism Division, National Buddhism Office; BMA district offices`

Publication year: `2019`

Target year: `2014`

Acquisition date (yyyymmdd): `20190930`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190930/transfer_1730651_files_296a713c/number of worship places 2014 by district _kn20190929.xlsx`

Number of temples (2014)

The count of temples recorded in each district was recorded, and evaluated with regard to population for each district.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

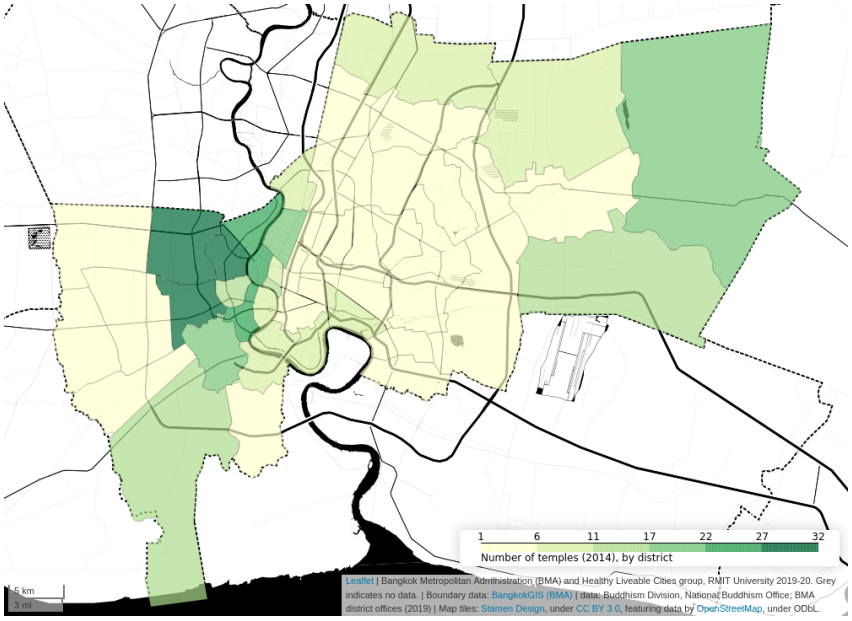


Fig. 347: Number of temples (2014), by district

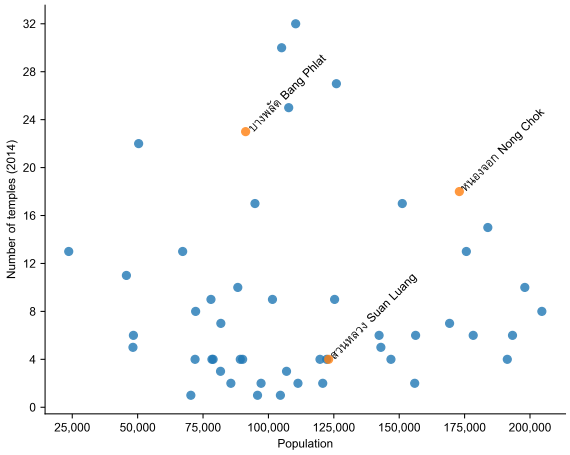


Fig. 348: Scatterplot of Temples by population for districts.

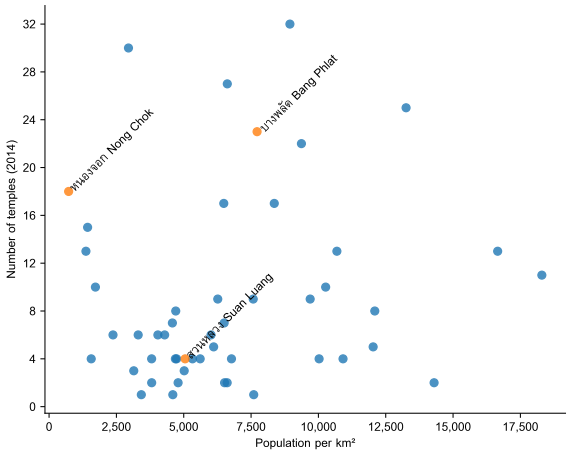


Fig. 349: Scatterplot of Temples by population density for districts.

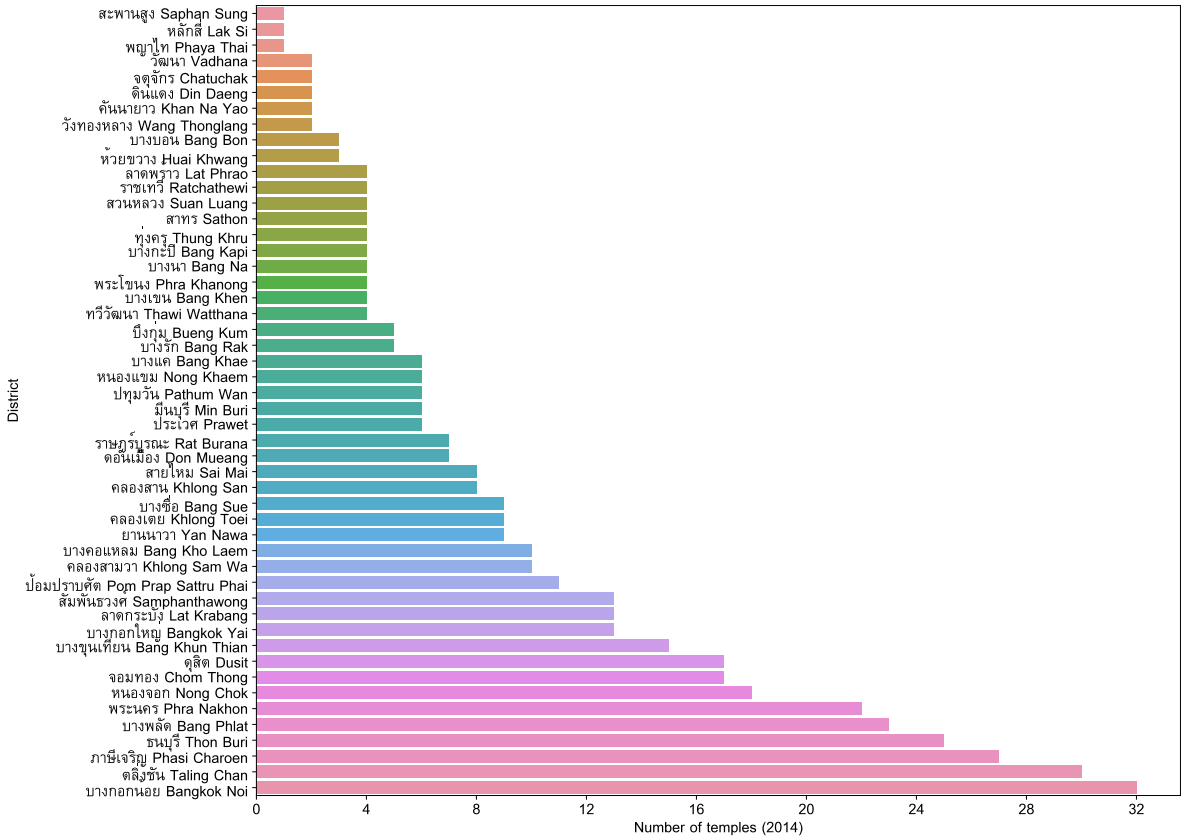


Fig. 350: Districts ranked in ascending order by temples with regard to number of temples (2014).

Number of temples (2014) per 1,000 population

The count of temples recorded in each district was recorded, and evaluated with regard to population for each district. The indicator was rated as the rate per 1,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

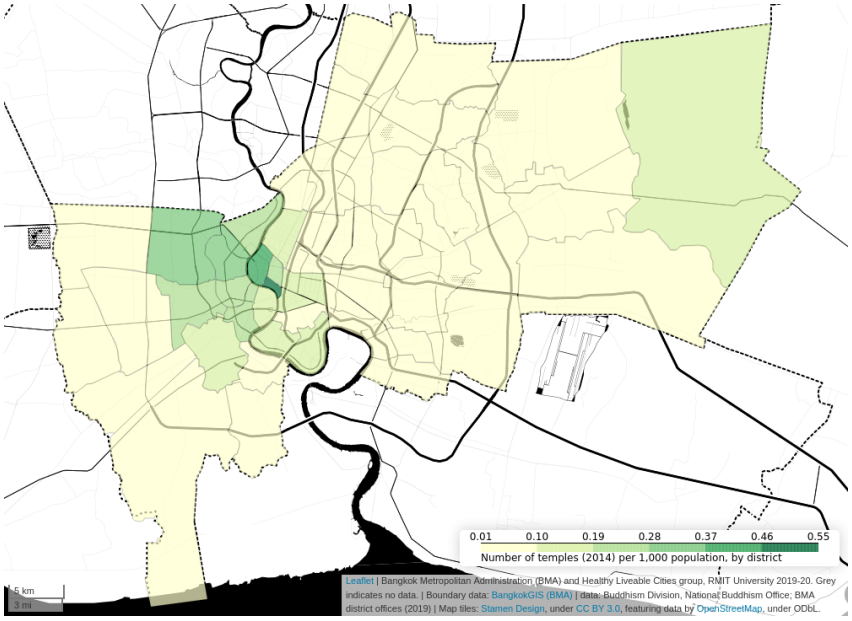


Fig. 351: Number of temples (2014) per 1,000 population, by district

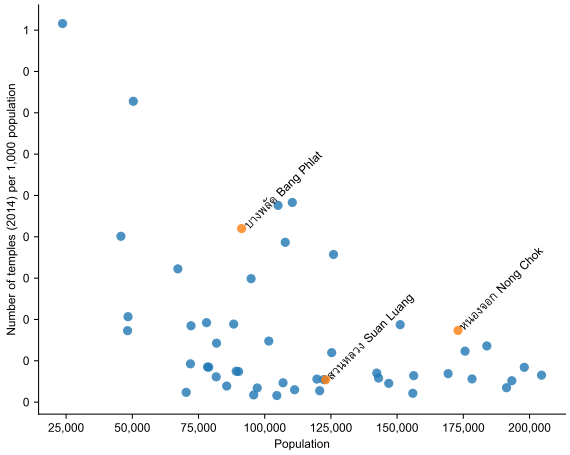


Fig. 352: Scatterplot of Temples by population for districts.

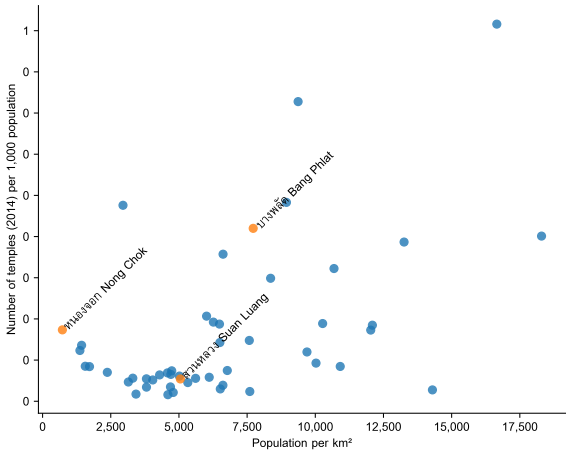


Fig. 353: Scatterplot of Temples by population density for districts.

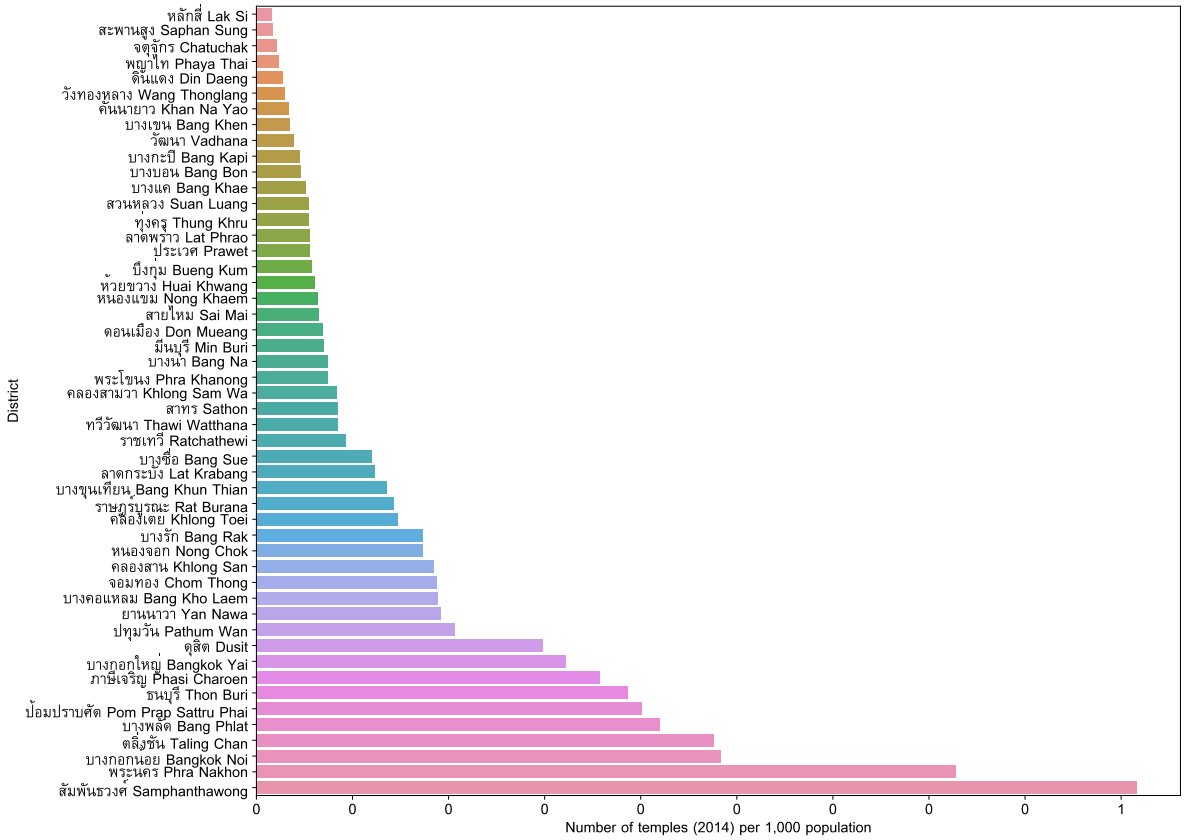


Fig. 354: Districts ranked in ascending order by temples with regard to number of temples (2014) per 1,000 population.

Dataset: BMA Libraries and Museums

Data on counts of libraries and museums by district and subdistrict were cleaned and associated with area linkage codes.

Data source: `Culture, Sports and Tourism Department BMA`

Publication year: `2018`

Target year: `2018`

Acquisition date (yyyymmdd): `20190911`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190911/transfer_1710171_files_127133c5/Library and Museum BKK 2018_kn082419.xlsx`

Number of museums (2018)

The count of temples recorded in each subdistrict were tallied for districts and subdistricts, and evaluated with regard to population for each district.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

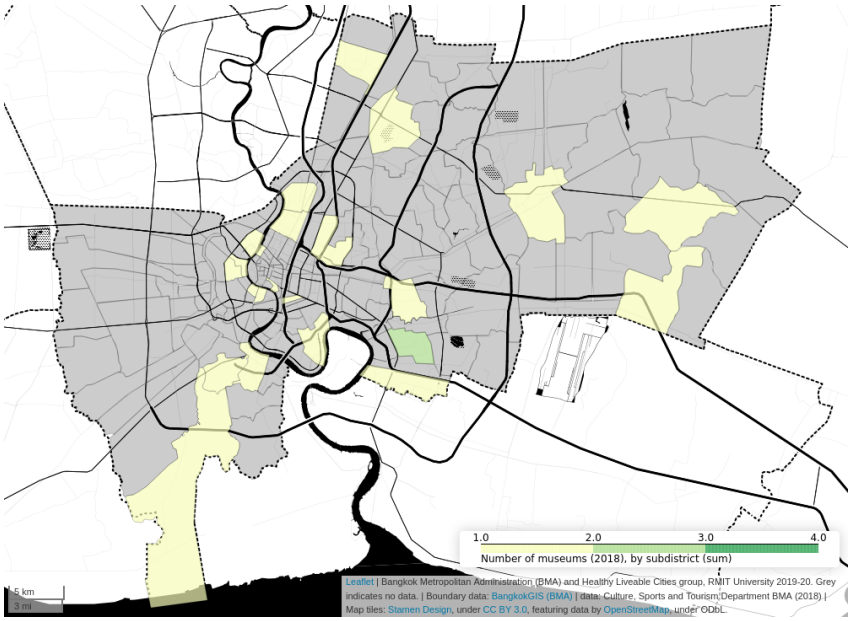


Fig. 355: Number of museums (2018), by subdistrict

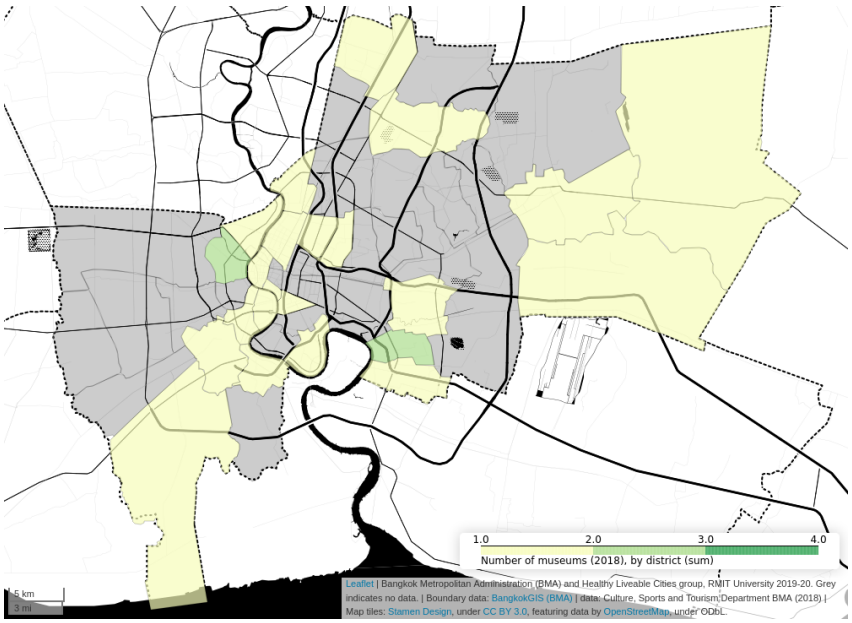


Fig. 356: Number of museums (2018), by district

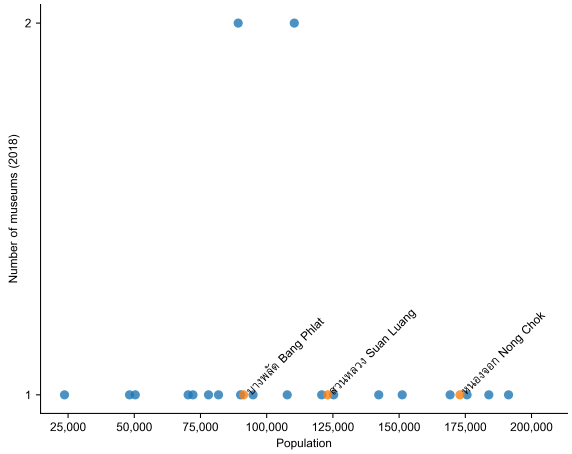


Fig. 357: Scatterplot of Number of Museums by population for districts.

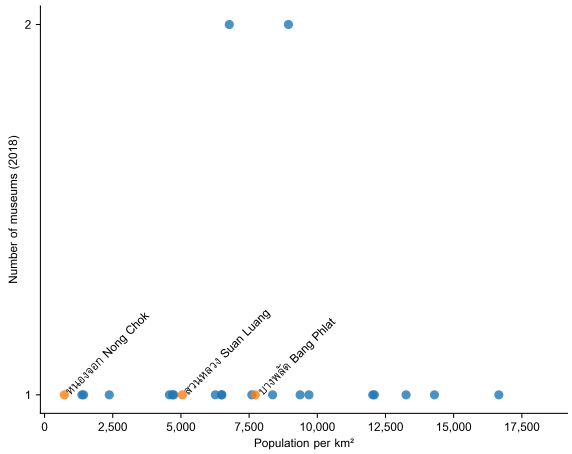


Fig. 358: Scatterplot of Number of Museums by population density for districts.

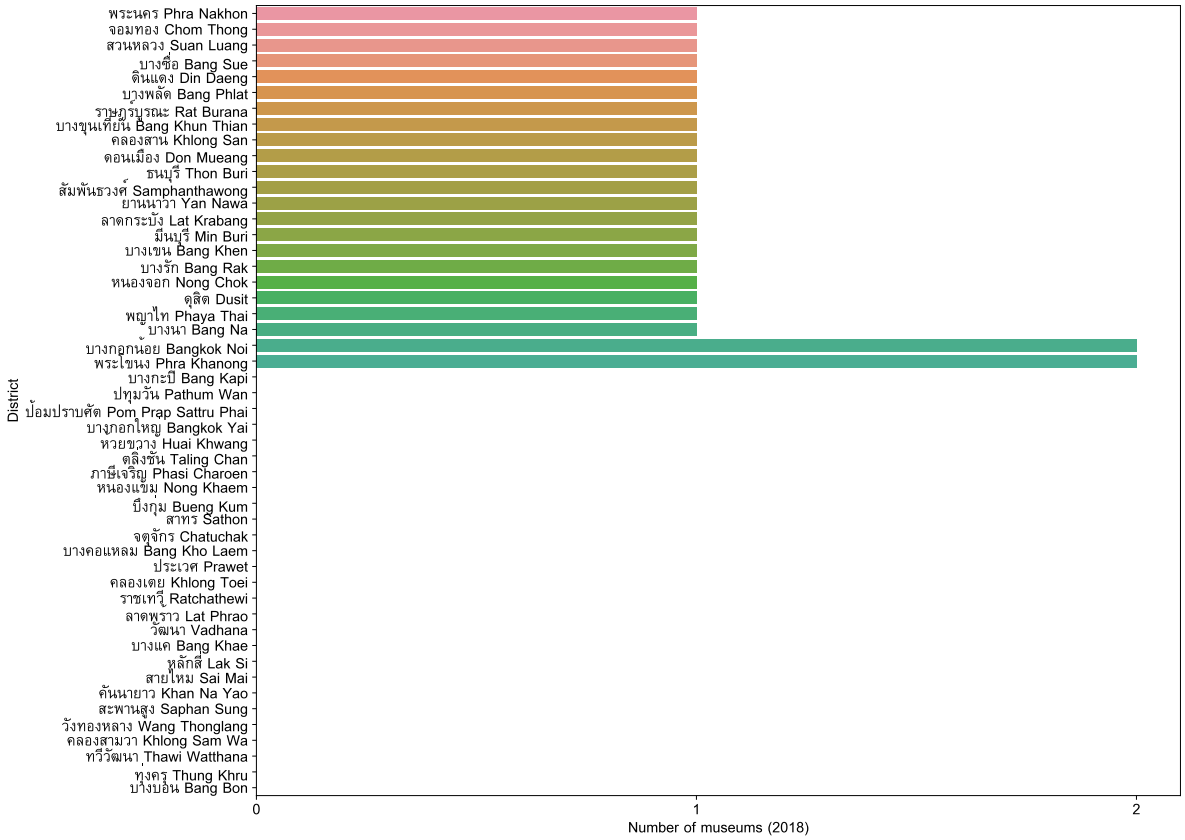


Fig. 359: Districts ranked in ascending order by number of museums with regard to number of museums (2018).

Number of museums (2018) per 1,000 population

The count of temples recorded in each subdistrict were tallied for districts and subdistricts, and evaluated with regard to population for each district. The indicator was rated as the rate per 1,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

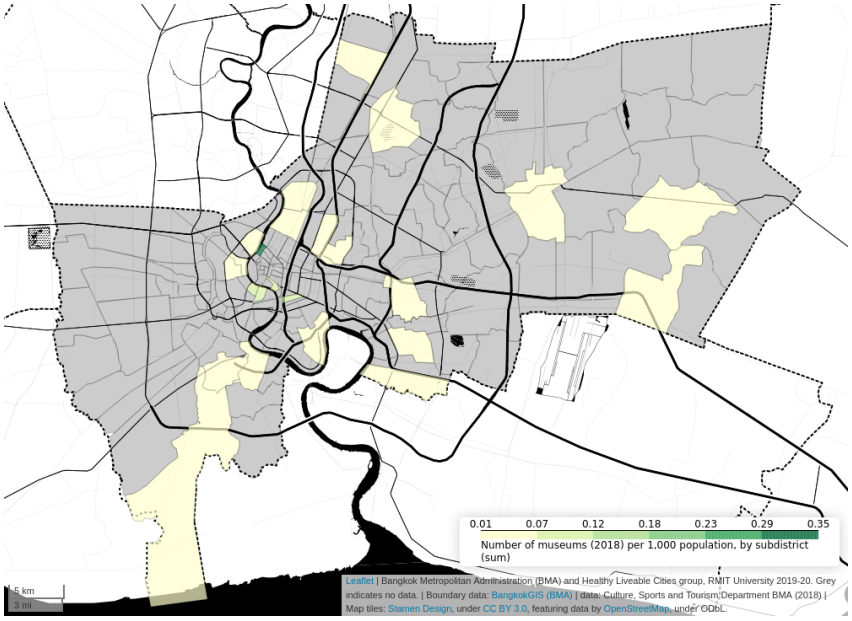


Fig. 360: Number of museums (2018) per 1,000 population, by subdistrict

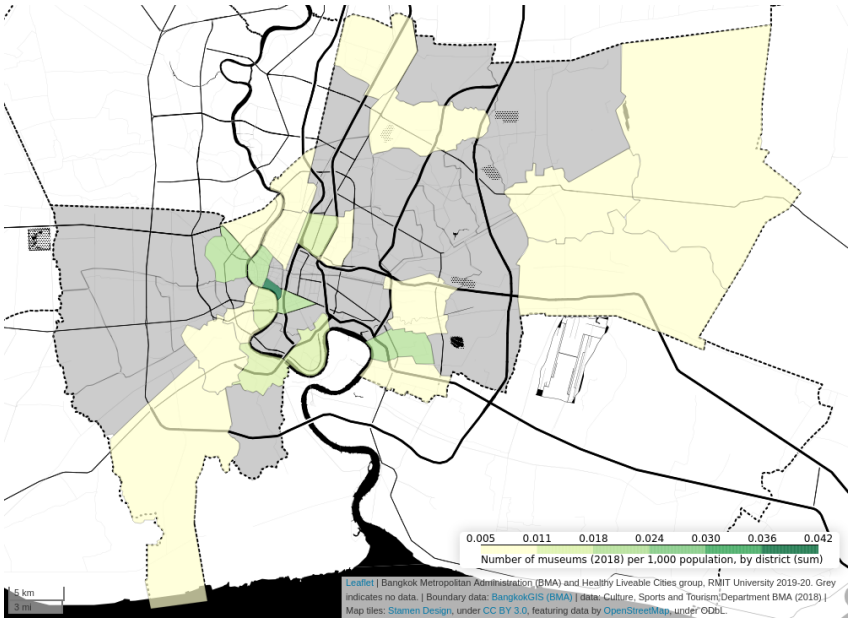


Fig. 361: Number of museums (2018) per 1,000 population, by district

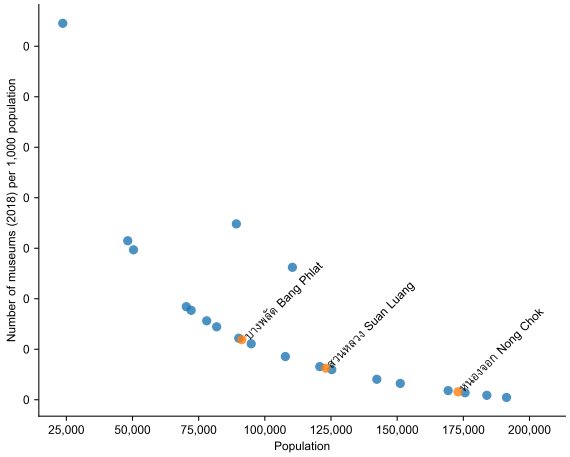


Fig. 362: Scatterplot of Number of Museums by population for districts.

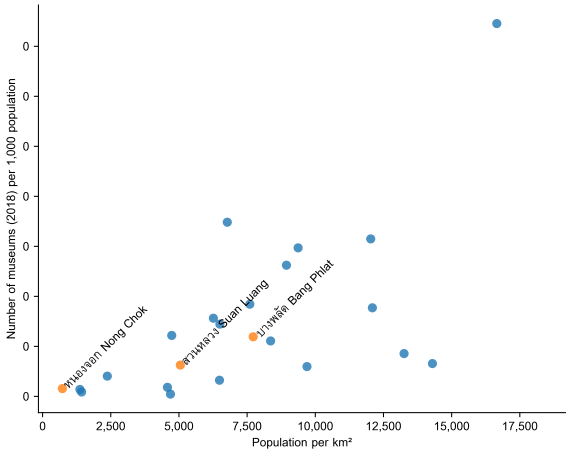


Fig. 363: Scatterplot of Number of Museums by population density for districts.

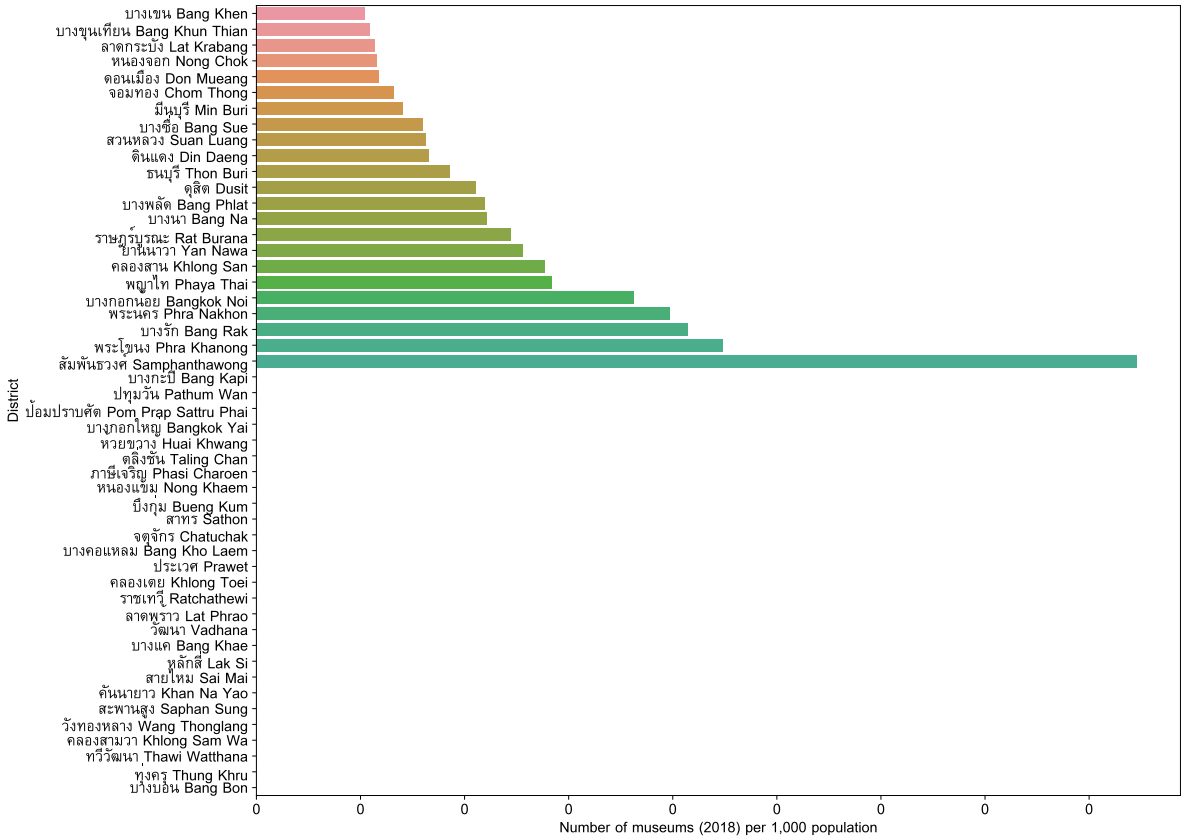


Fig. 364: Districts ranked in ascending order by number of museums with regard to number of museums (2018) per 1,000 population.

Dataset: BMA Youth centers

Data on counts of youth centers, sports centers and sport yards and their usage counts within Bangkok districts (2018) were cleaned and associated with area linkage codes.

Data source: `Culture, Sports and Tourism Department BMA`

Publication year: `2018`

Target year: `2018`

Acquisition date (yyyymmdd): `20190911`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20190911/transfer_1710171_files_127133c5/Youth centers in Bangkok 2018_kn 20190909.xlsx`

Number of youth centers (2018)

The number of youth centers was recorded for each district.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

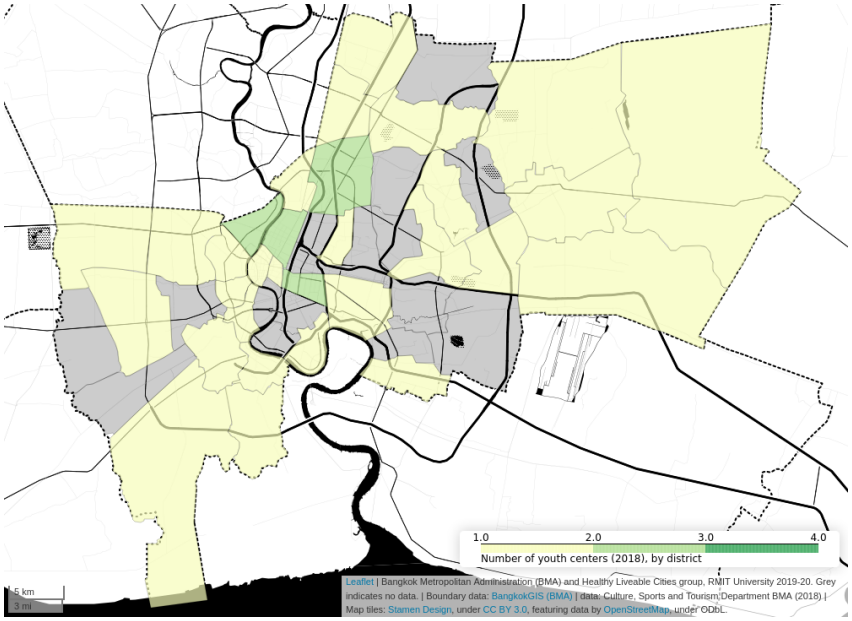


Fig. 365: Number of youth centers (2018), by district

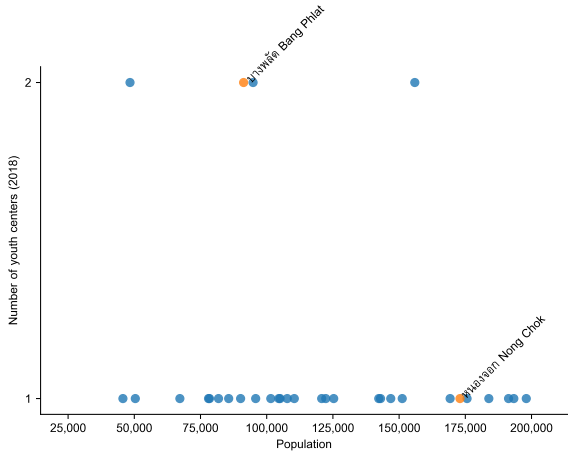


Fig. 366: Scatterplot of Youth centers by population for districts.

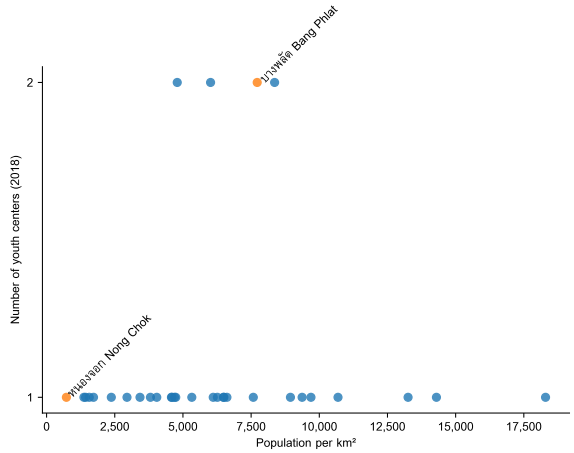


Fig. 367: Scatterplot of Youth centers by population density for districts.

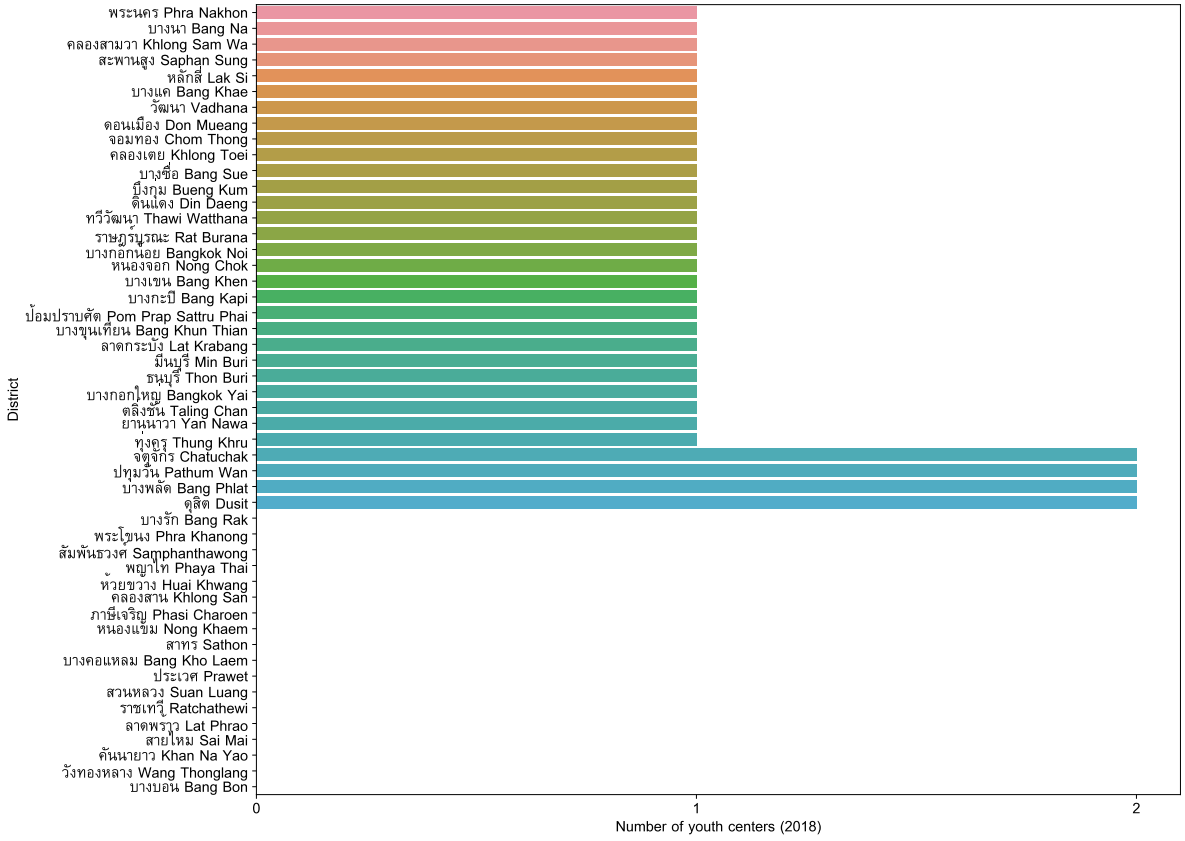


Fig. 368: Districts ranked in ascending order by youth centers with regard to number of youth centers (2018).

Number of youth centers (2018) per 1,000 population

The number of youth centers was recorded for each district. The indicator was rated as the rate per 1,000 population. Aligns with Sustainable Development Goals: 2.1, 3, 11.

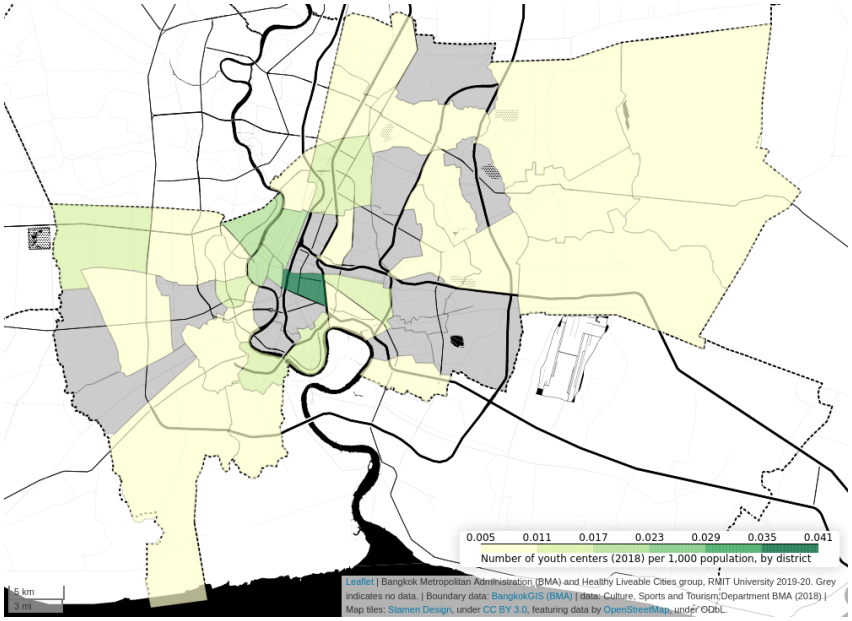


Fig. 369: Number of youth centers (2018) per 1,000 population, by district

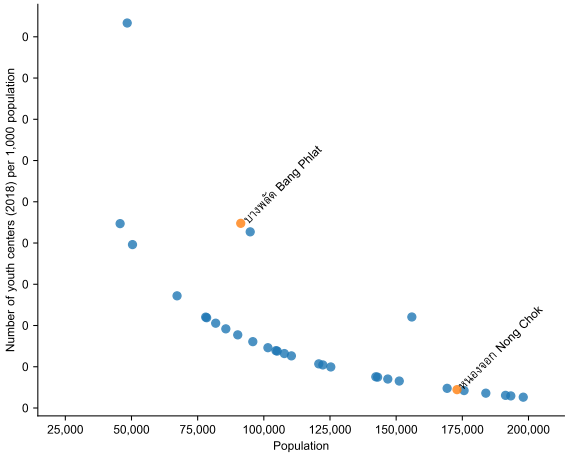


Fig. 370: Scatterplot of Youth centers by population for districts.

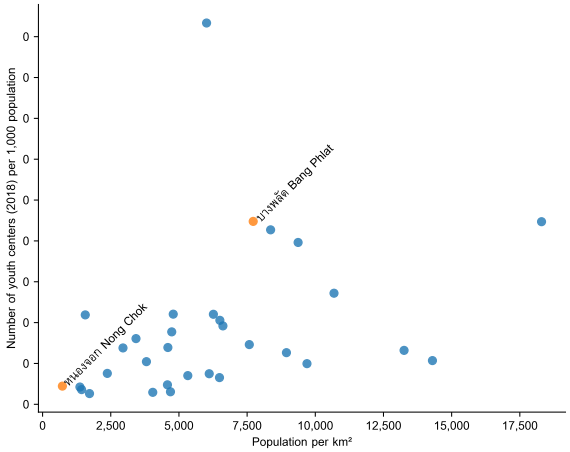


Fig. 371: Scatterplot of Youth centers by population density for districts.

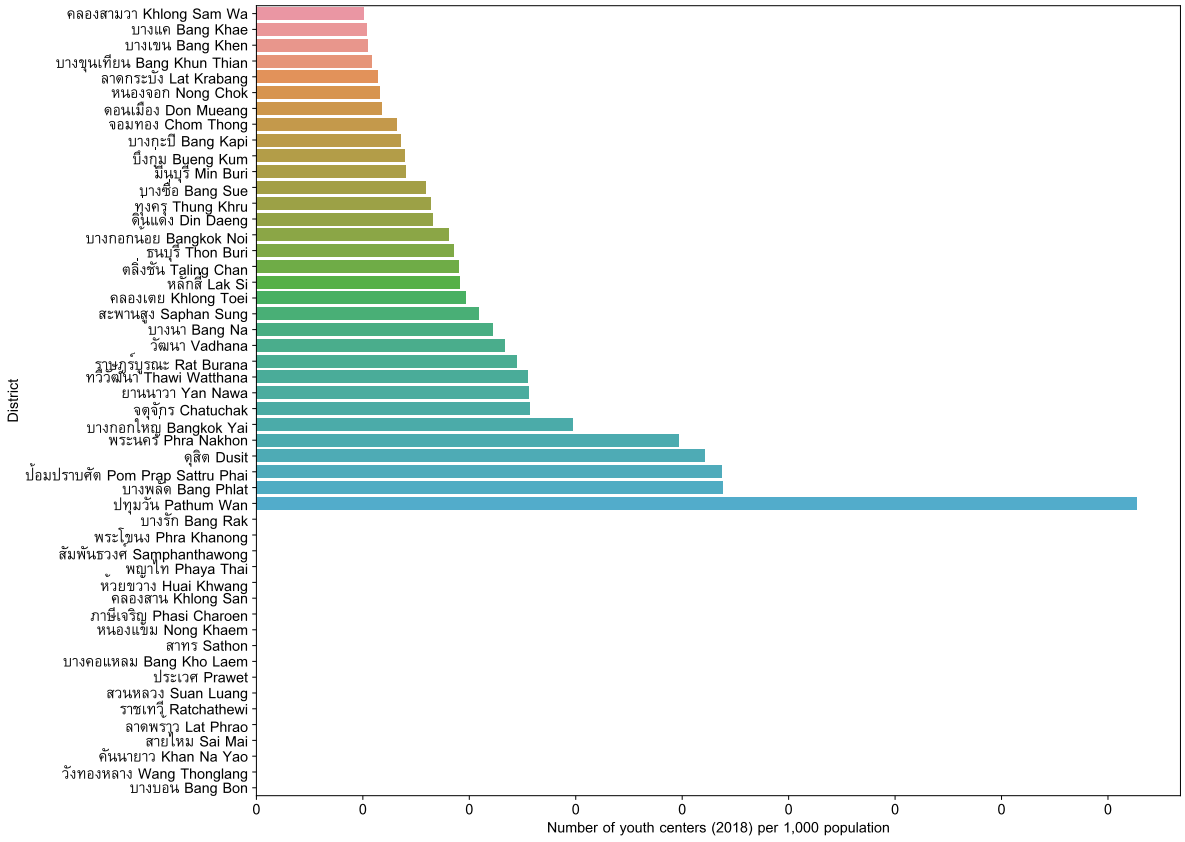


Fig. 372: Districts ranked in ascending order by youth centers with regard to number of youth centers (2018) per 1,000 population.

Visits to youth centers (2018)

The number of visits to youth centers within each district was recorded.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

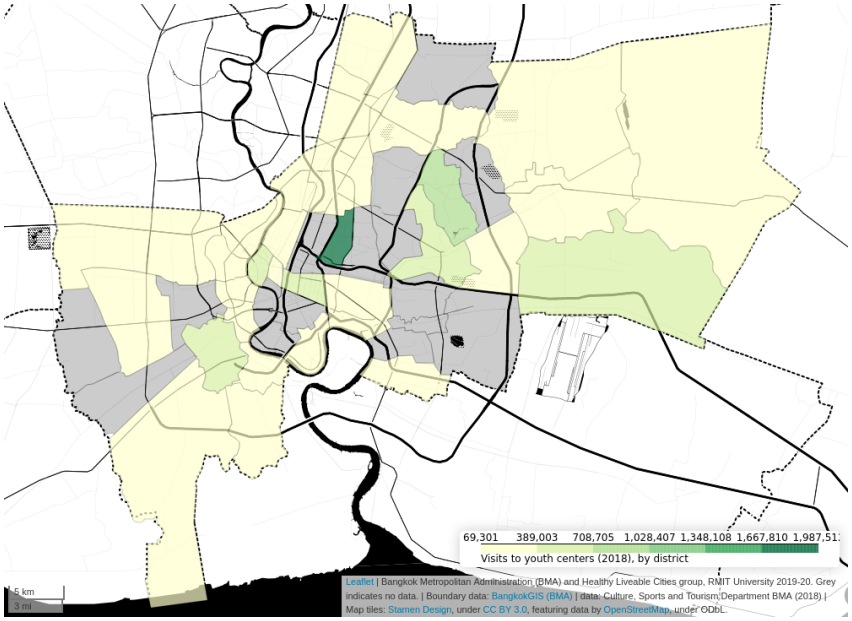


Fig. 373: Visits to youth centers (2018), by district

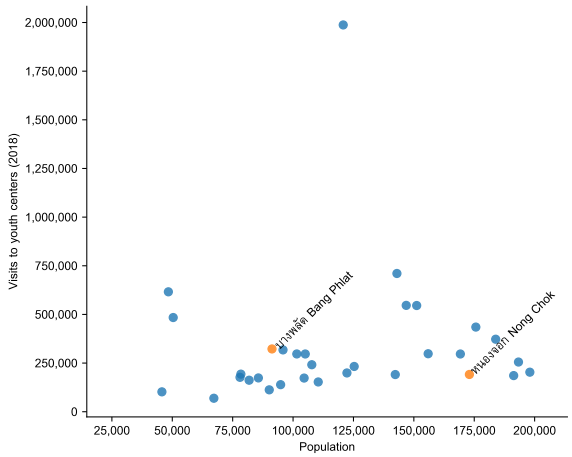


Fig. 374: Scatterplot of Youth center visits by population for districts.

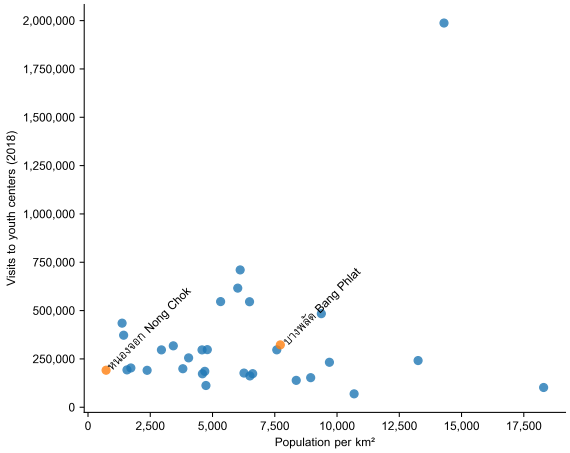


Fig. 375: Scatterplot of Youth center visits by population density for districts.

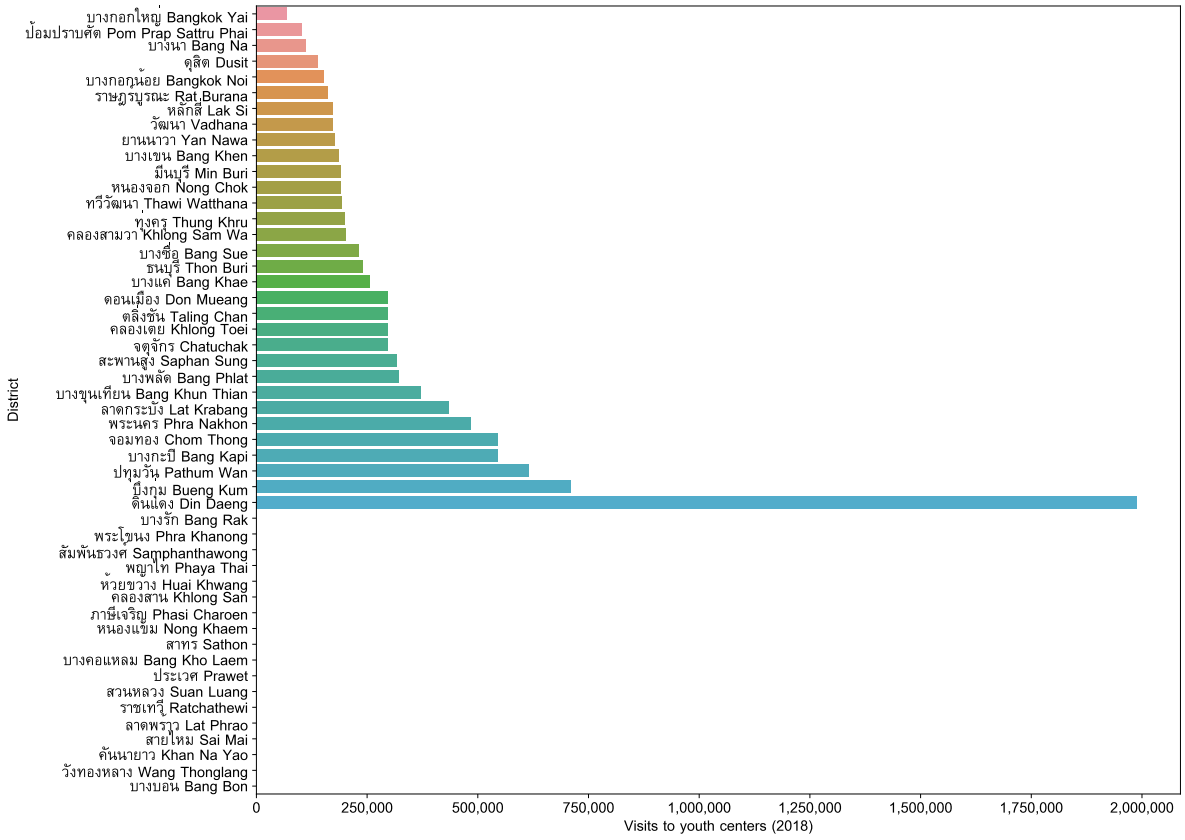


Fig. 376: Districts ranked in ascending order by youth center visits with regard to visits to youth centers (2018).

Visits to youth centers (2018) per 1,000 population

The number of visits to youth centers within each district was recorded. The indicator was rated as the rate per 1,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

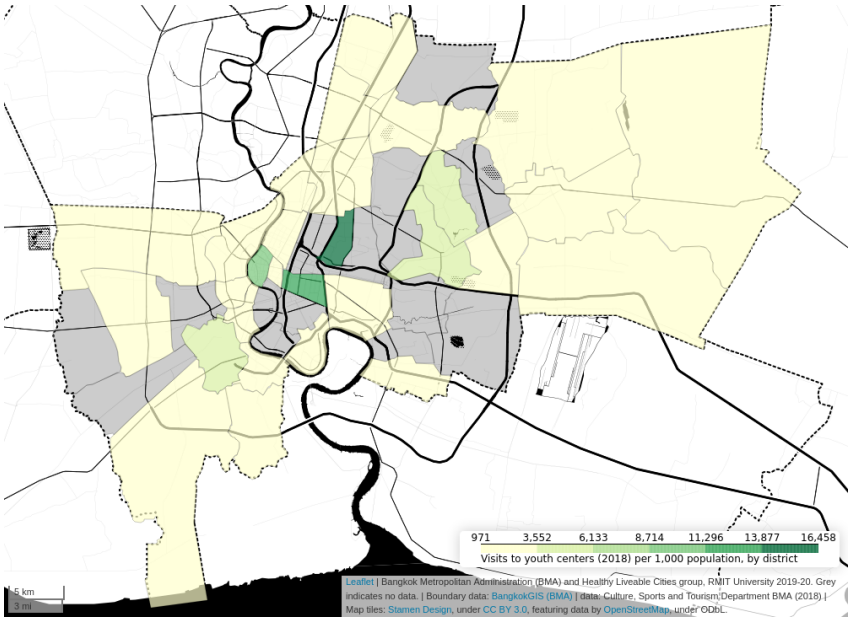


Fig. 377: Visits to youth centers (2018) per 1,000 population, by district

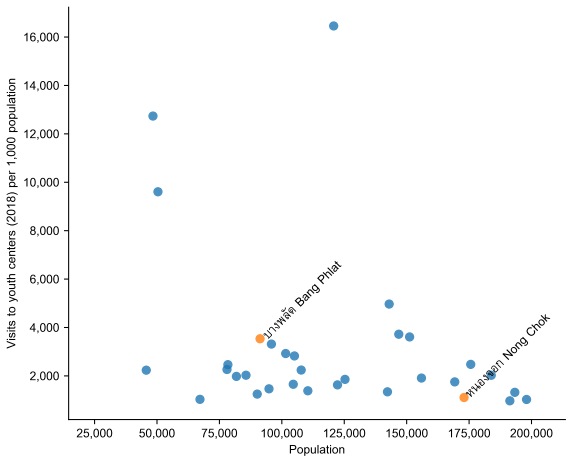


Fig. 378: Scatterplot of Youth center visits by population for districts.

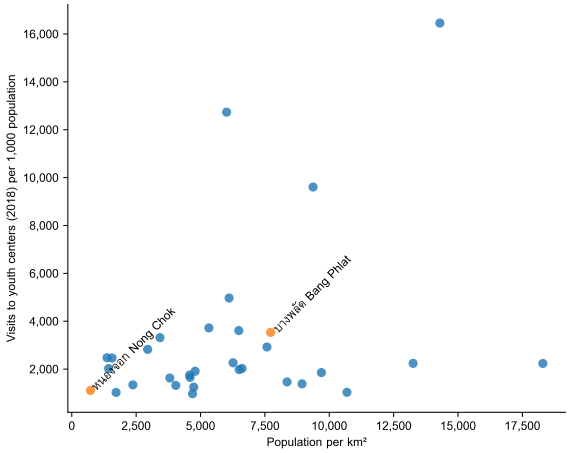


Fig. 379: Scatterplot of Youth center visits by population density for districts.

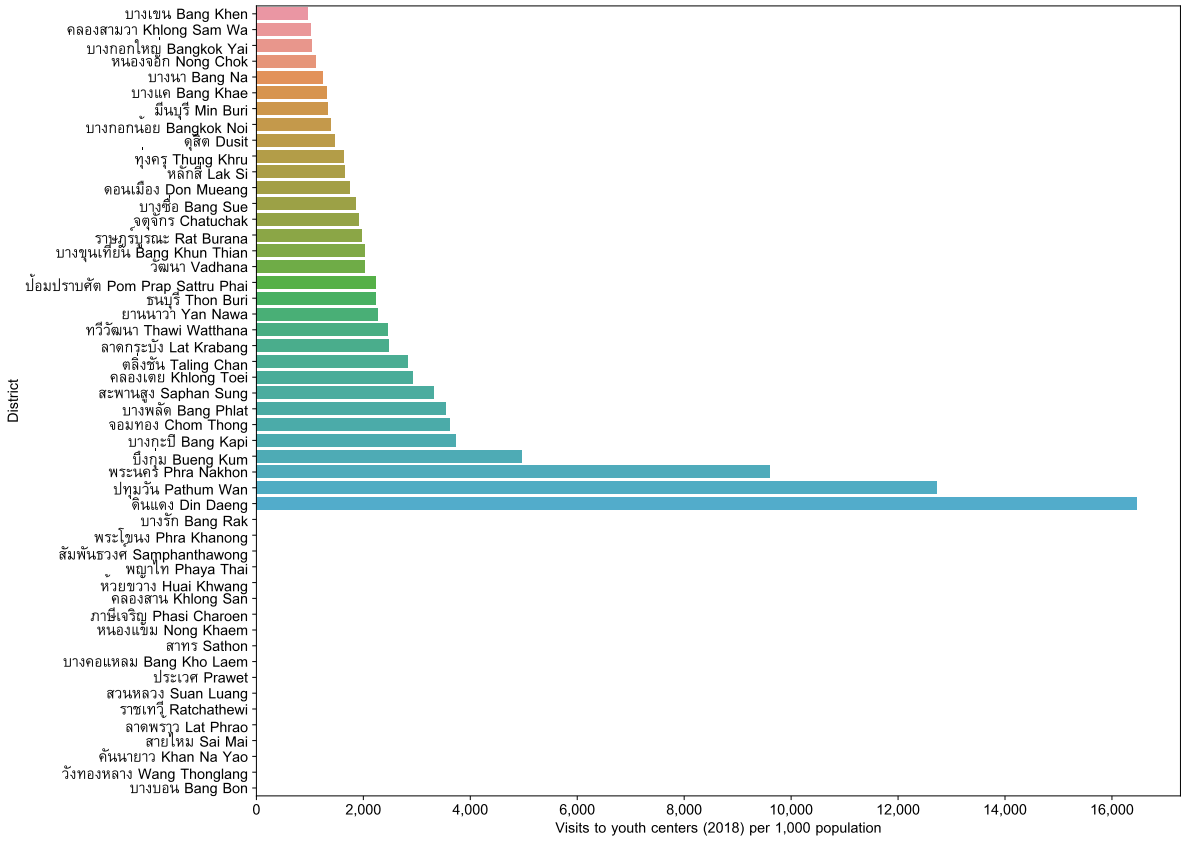


Fig. 380: Districts ranked in ascending order by youth center visits with regard to visits to youth centers (2018) per 1,000 population.

Number of sport centers (2018)

The number of sport centers was recorded for each district.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

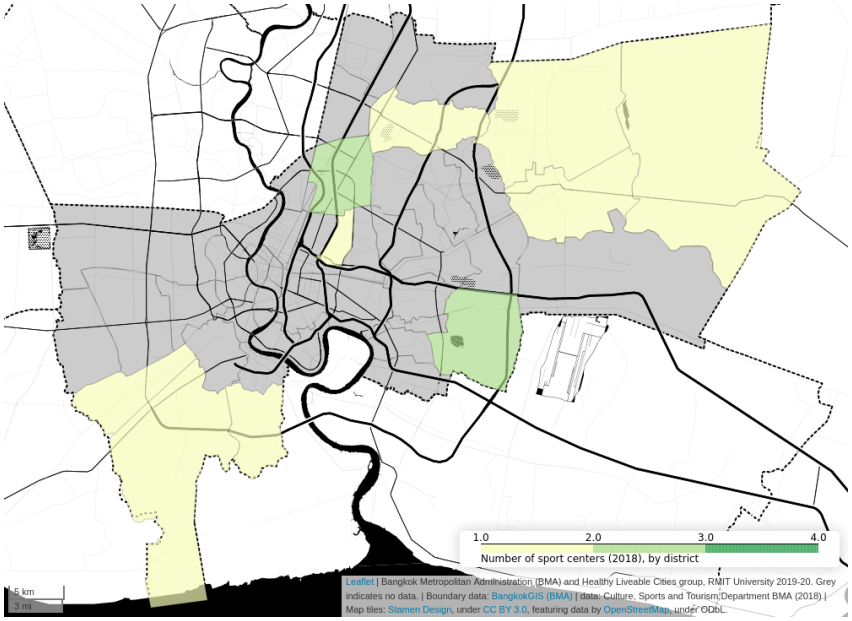


Fig. 381: Number of sport centers (2018), by district

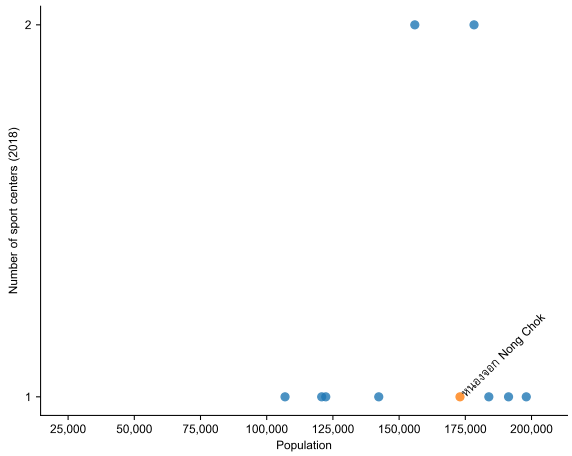


Fig. 382: Scatterplot of Sport centers by population for districts.

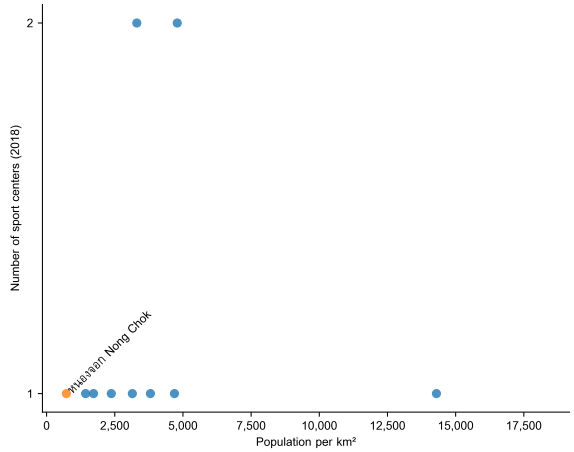


Fig. 383: Scatterplot of Sport centers by population density for districts.

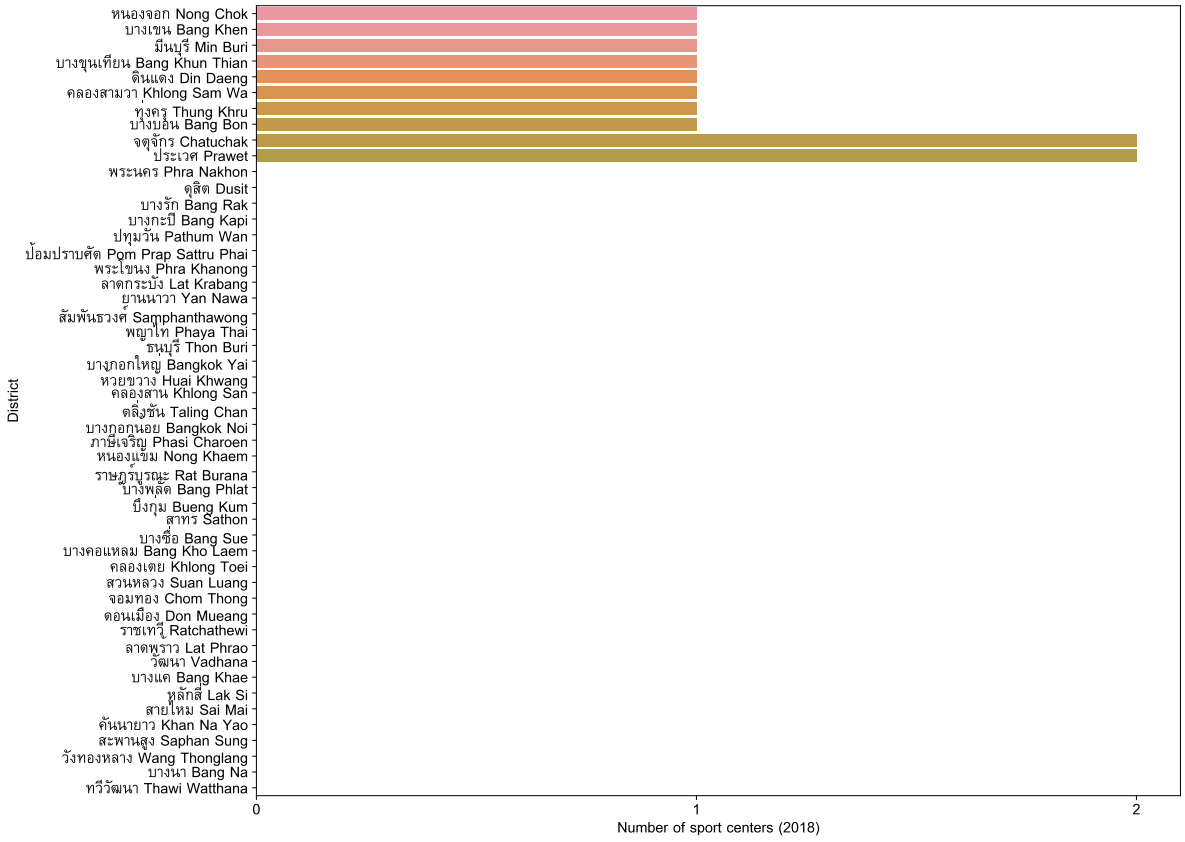


Fig. 384: Districts ranked in ascending order by sport centers with regard to number of sport centers (2018).

Number of sport centers (2018) per 1,000 population

The number of sport centers was recorded for each district. The indicator was rated as the rate per 1,000 population. Aligns with Sustainable Development Goals: 2.1, 3, 11.

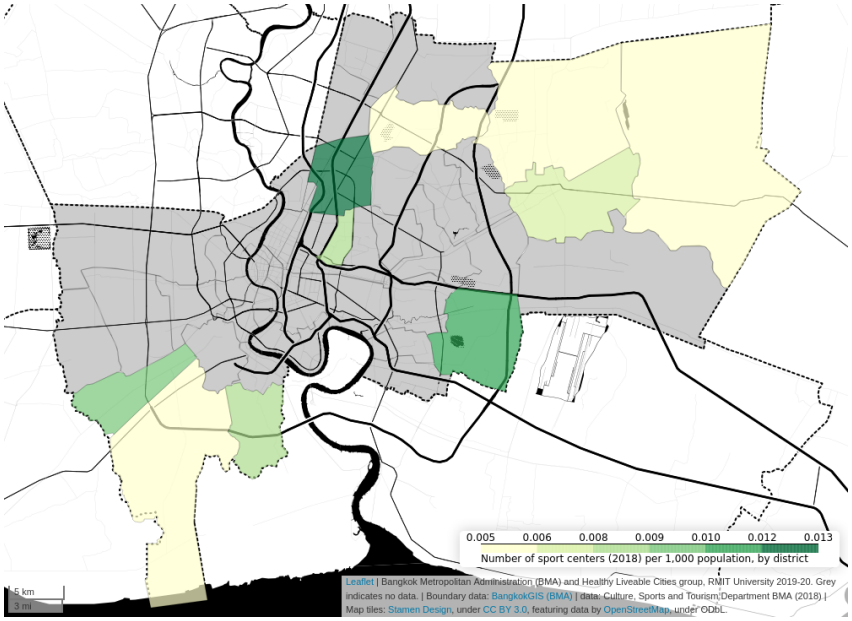


Fig. 385: Number of sport centers (2018) per 1,000 population, by district

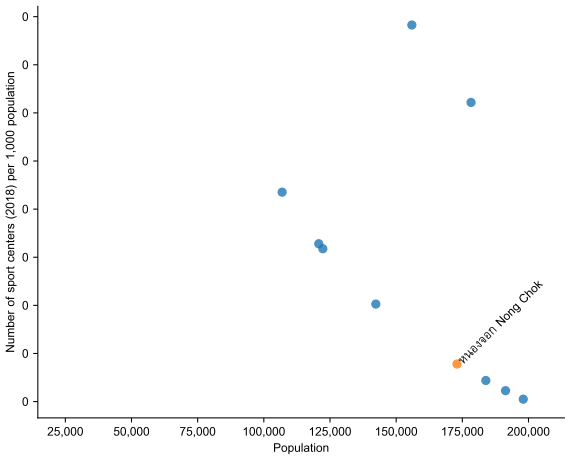


Fig. 386: Scatterplot of Sport centers by population for districts.

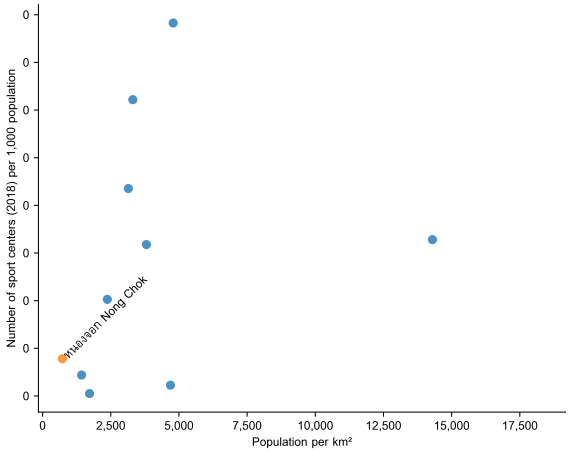


Fig. 387: Scatterplot of Sport centers by population density for districts.

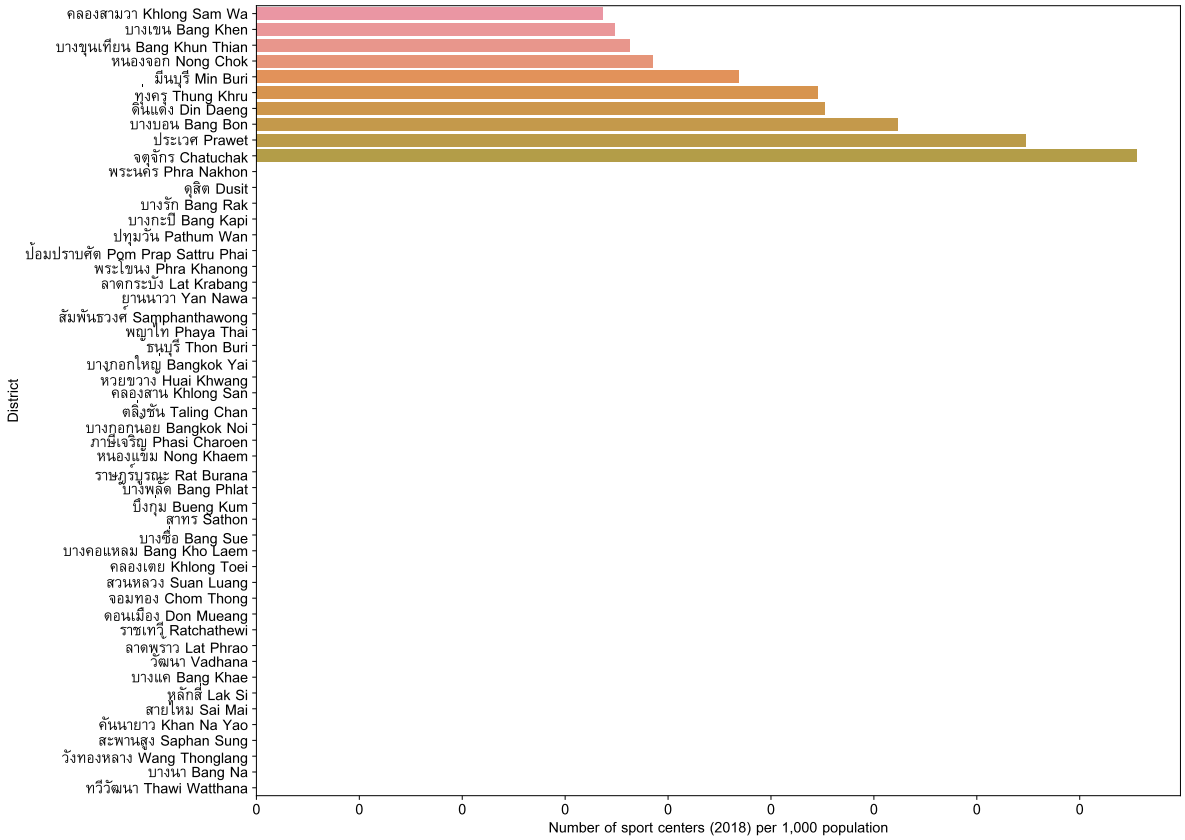


Fig. 388: Districts ranked in ascending order by sport centers with regard to number of sport centers (2018) per 1,000 population.

Visits to sport centers (2018)

The number of visits to sport centers within each district was recorded.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

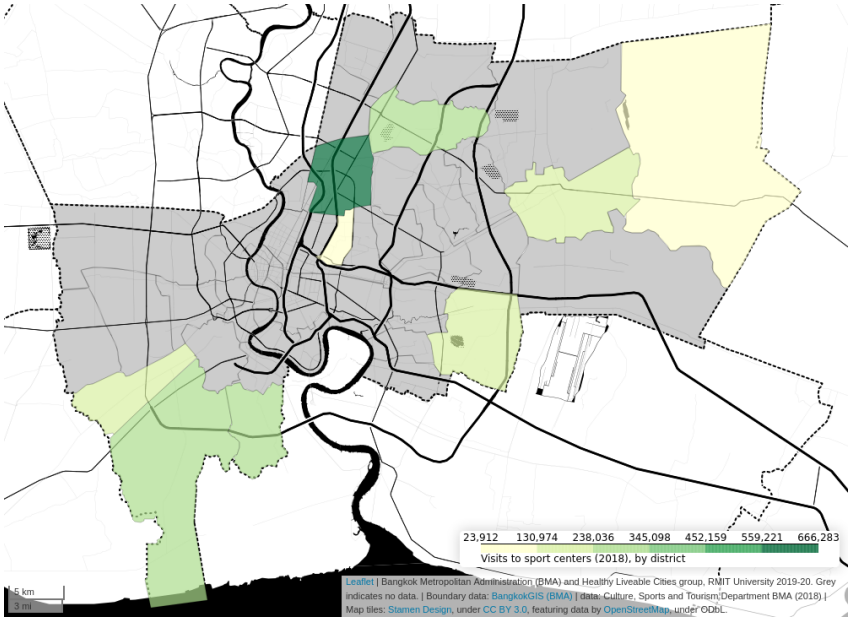


Fig. 389: Visits to sport centers (2018), by district

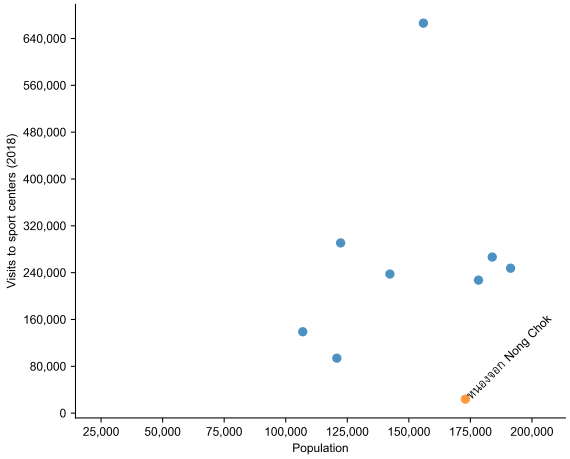


Fig. 390: Scatterplot of Sport center visits by population for districts.

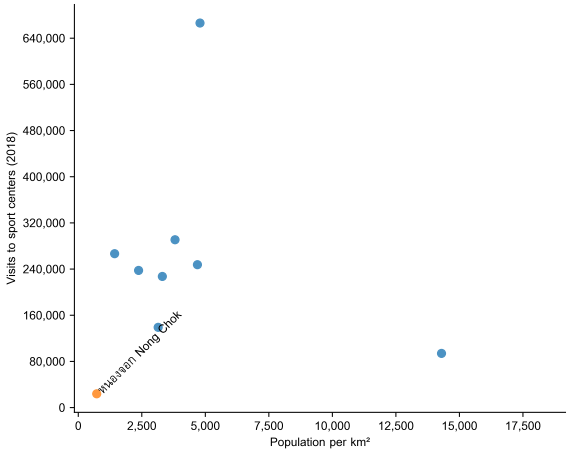


Fig. 391: Scatterplot of Sport center visits by population density for districts.

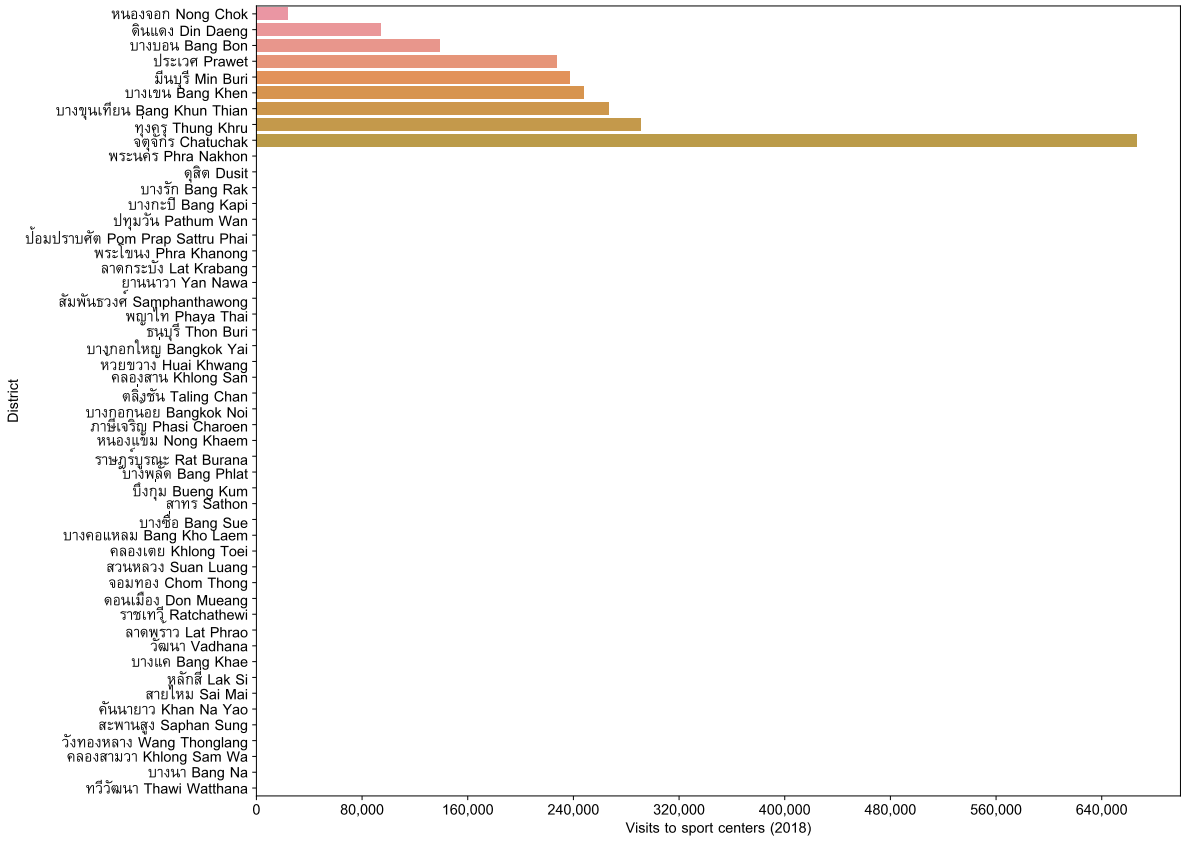


Fig. 392: Districts ranked in ascending order by sport center visits with regard to visits to sport centers (2018).

Visits to sport centers (2018) per 1,000 population

The number of visits to sport centers within each district was recorded. The indicator was rated as the rate per 1,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

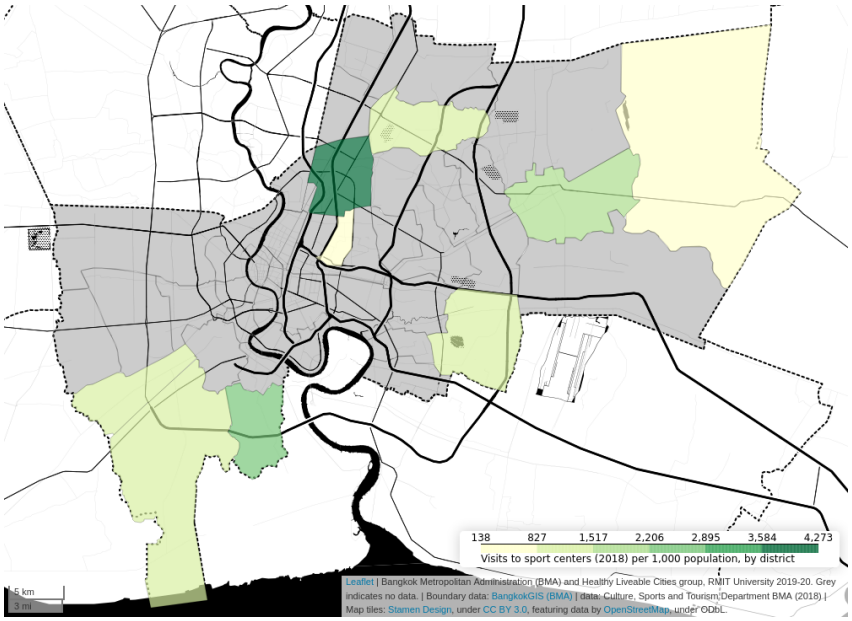
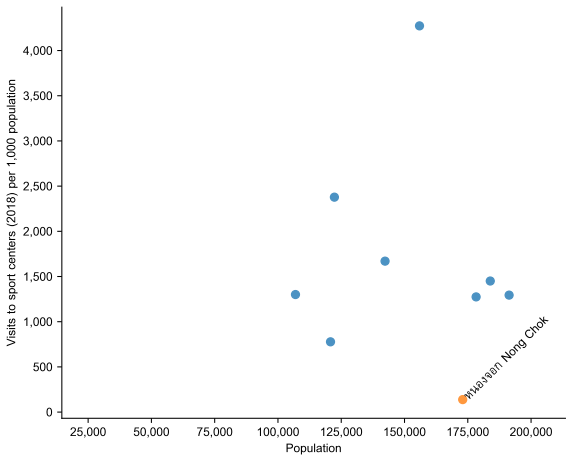


Fig. 393: Visits to sport centers (2018) per 1,000 population, by district


Visits to sport centers (2018) per 1,000 population
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
25,000
50,000
75,000
100,000
125,000
150,000
175,000
200,000
Population
Bangkok Noi
Bangkok Yai
Bang Kho Laem
Khlong San
Thon Buri
Bangkok Yai
Bangkok Noi
Bang Kho Laem
Khlong San
Thon Buri
Bangkok Noi
Bangkok Yai

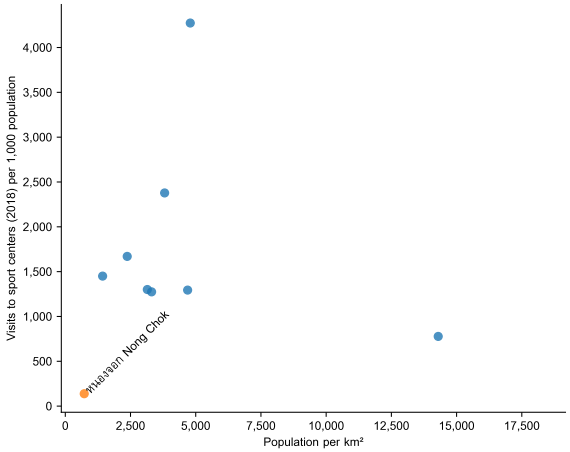


Fig. 395: Scatterplot of Sport center visits by population density for districts.

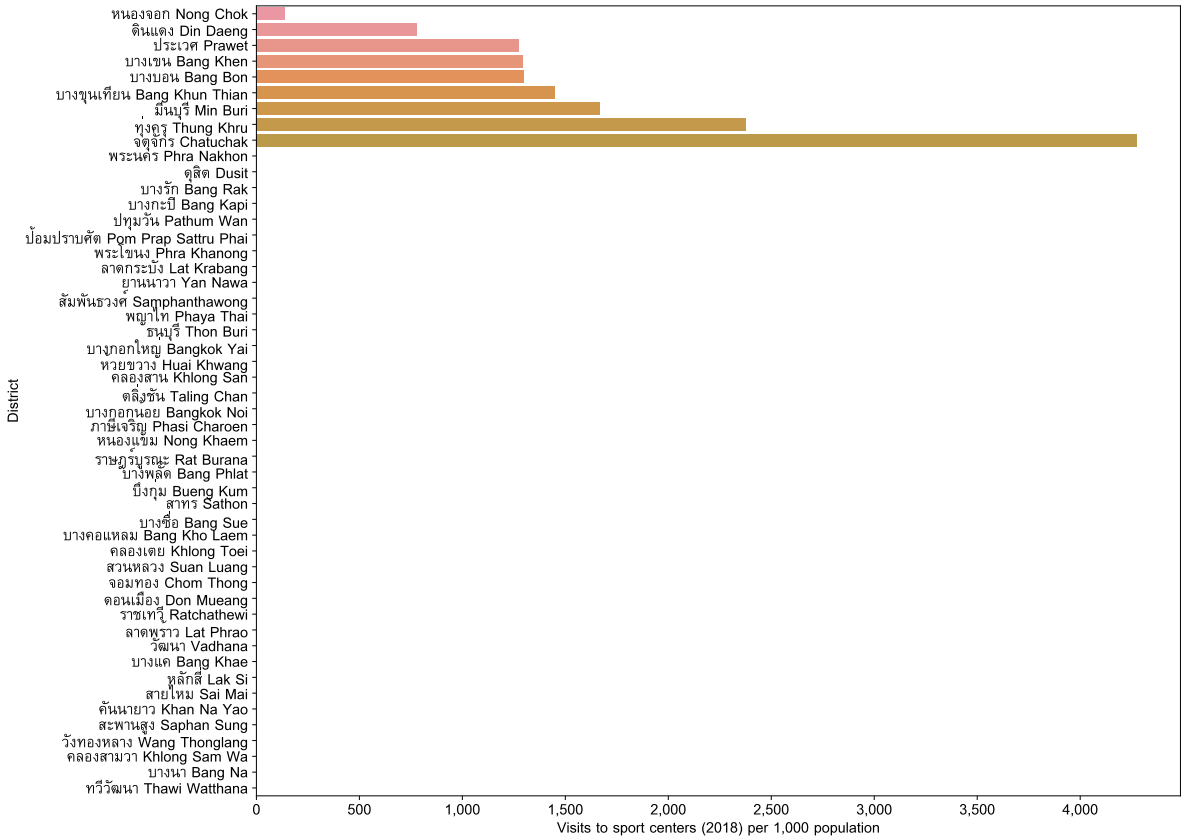


Fig. 396: Districts ranked in ascending order by sport center visits with regard to visits to sport centers (2018) per 1,000 population.

Number of sport yards (2018)

The number of sport yards was recorded for each district.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

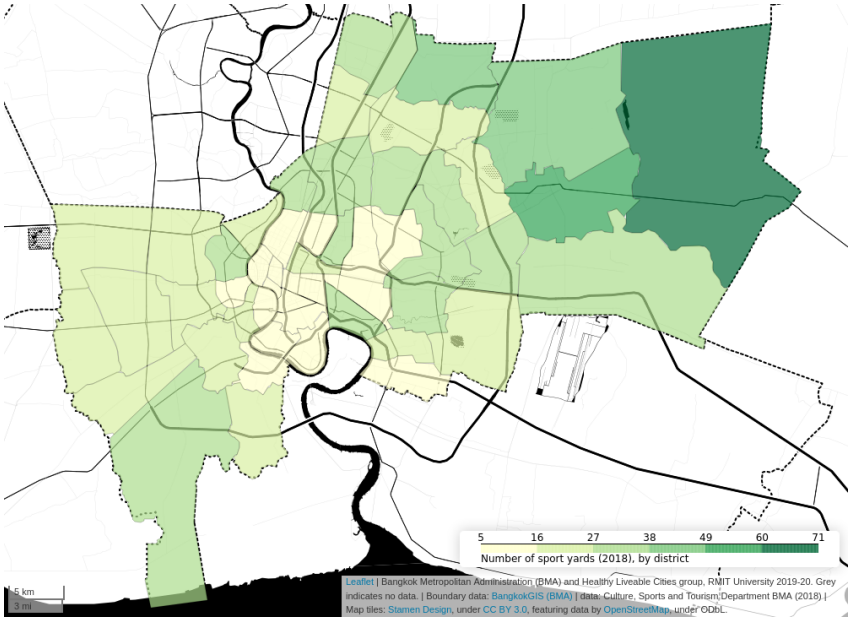


Fig. 397: Number of sport yards (2018), by district

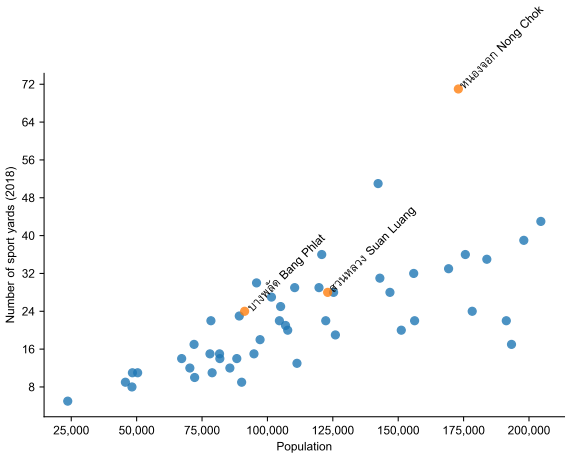


Fig. 398: Scatterplot of Sport yards by population for districts.

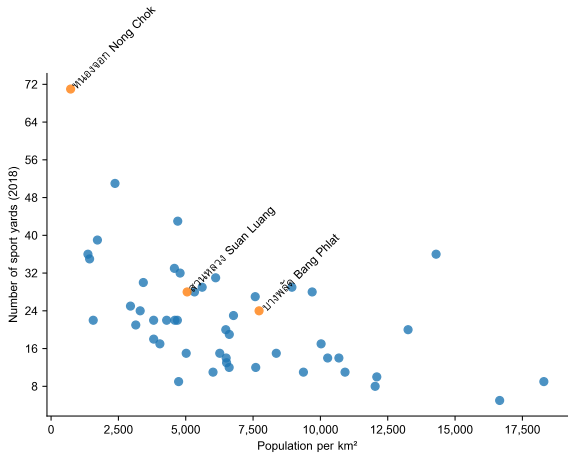


Fig. 399: Scatterplot of Sport yards by population density for districts.

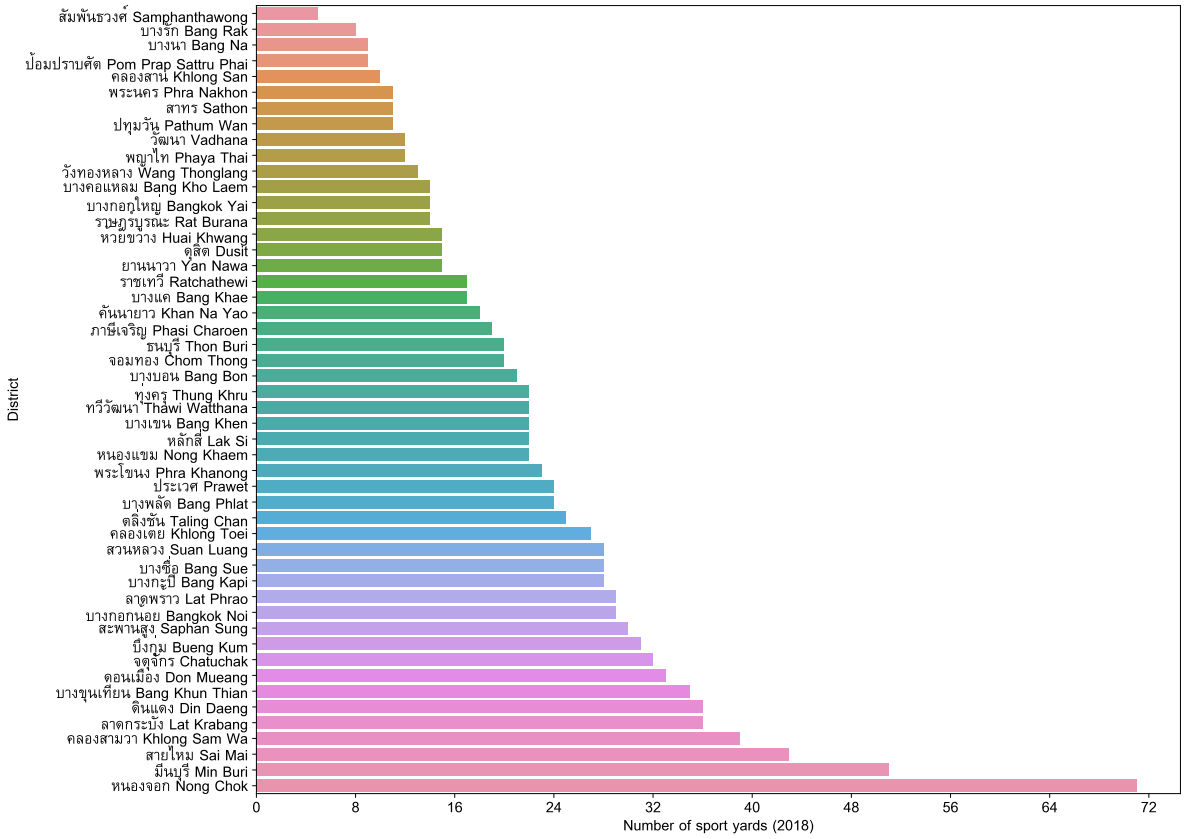


Fig. 400: Districts ranked in ascending order by sport yards with regard to number of sport yards (2018).

Number of sport yards (2018) per 1,000 population

The number of sport yards was recorded for each district. The indicator was rated as the rate per 1,000 population. Aligns with Sustainable Development Goals: 2.1, 3, 11.

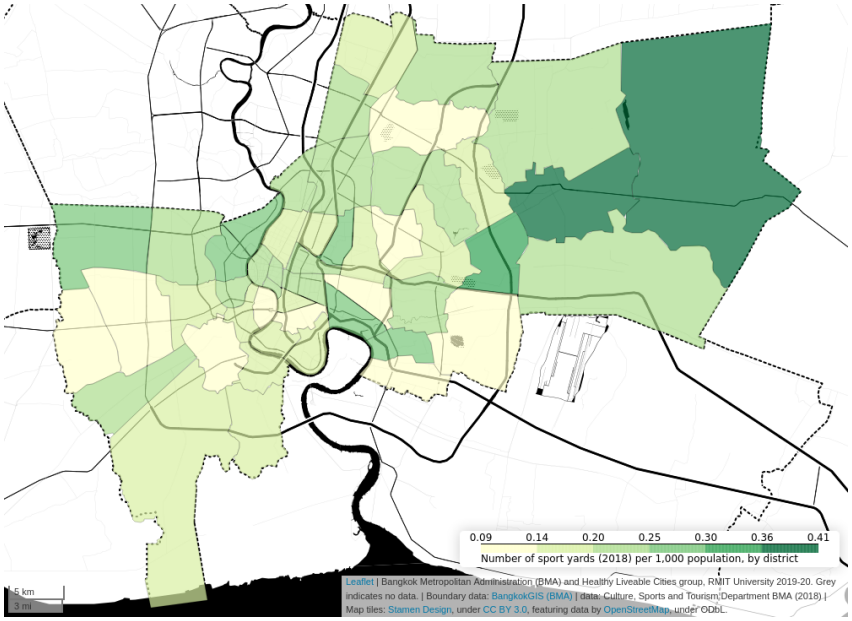


Fig. 401: Number of sport yards (2018) per 1,000 population, by district

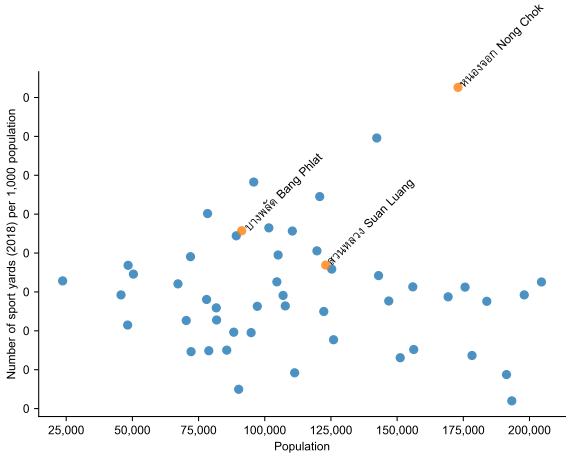


Fig. 402: Scatterplot of Sport yards by population for districts.

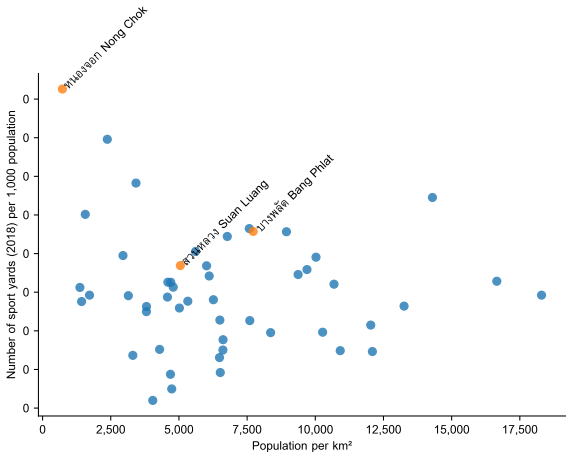


Fig. 403: Scatterplot of Sport yards by population density for districts.

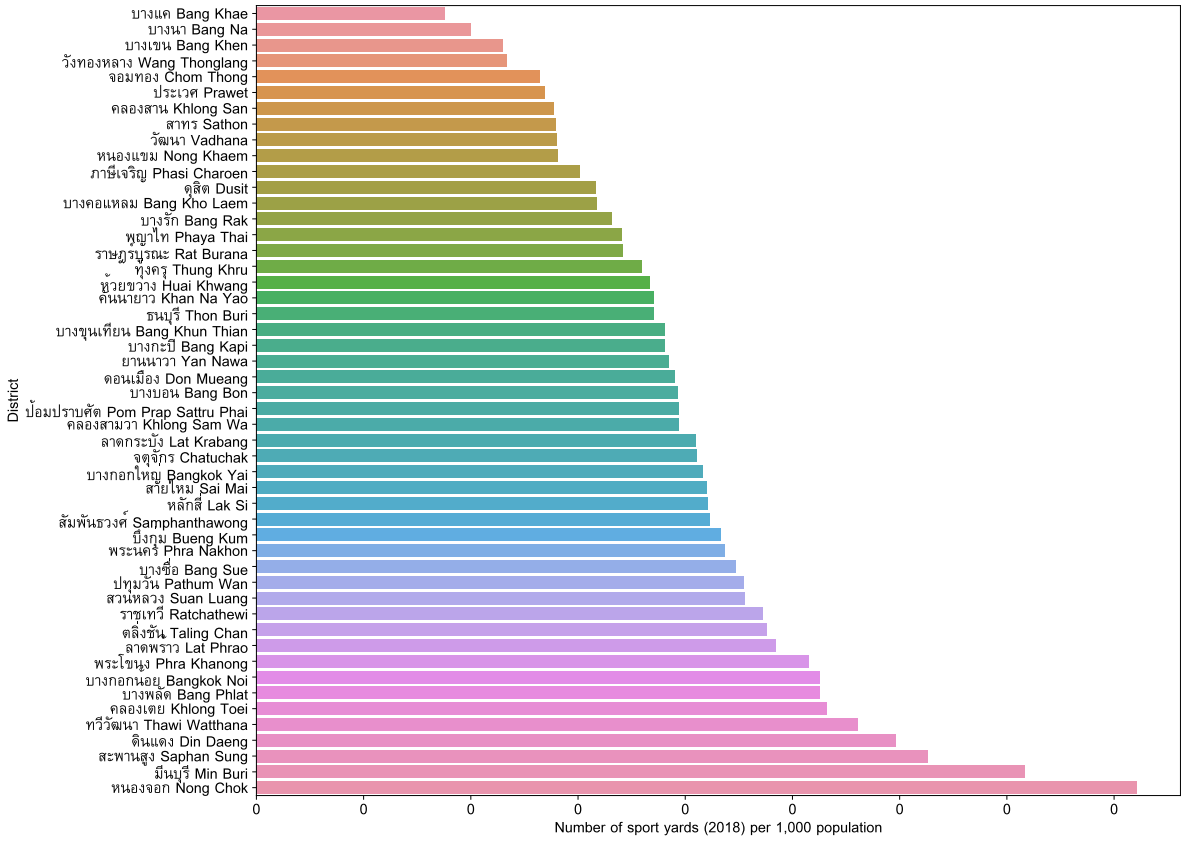


Fig. 404: Districts ranked in ascending order by sport yards with regard to number of sport yards (2018) per 1,000 population.

Visits to sport yards (2018)

The number of visits to sport yards within each district was recorded.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

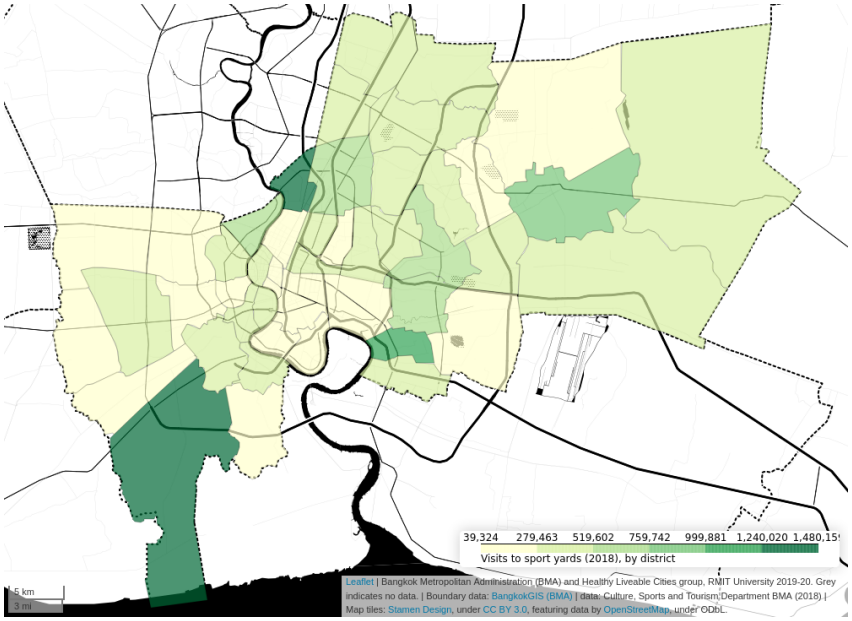


Fig. 405: Visits to sport yards (2018), by district

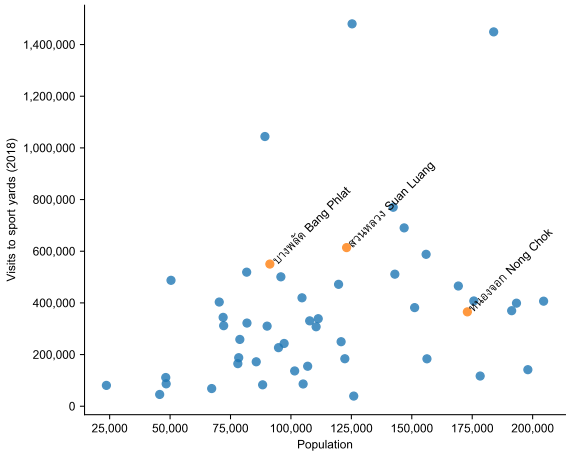


Fig. 406: Scatterplot of Sport yard visits by population for districts.

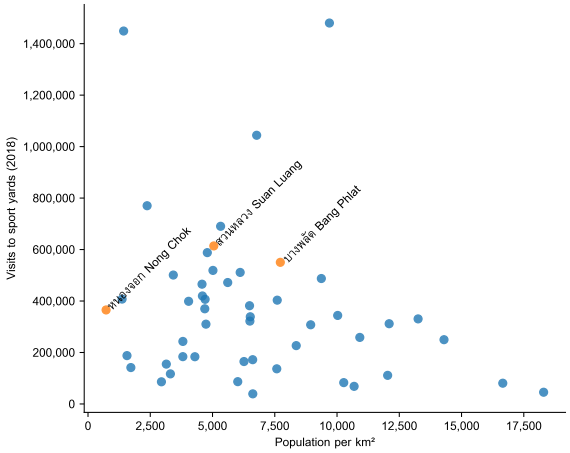


Fig. 407: Scatterplot of Sport yard visits by population density for districts.

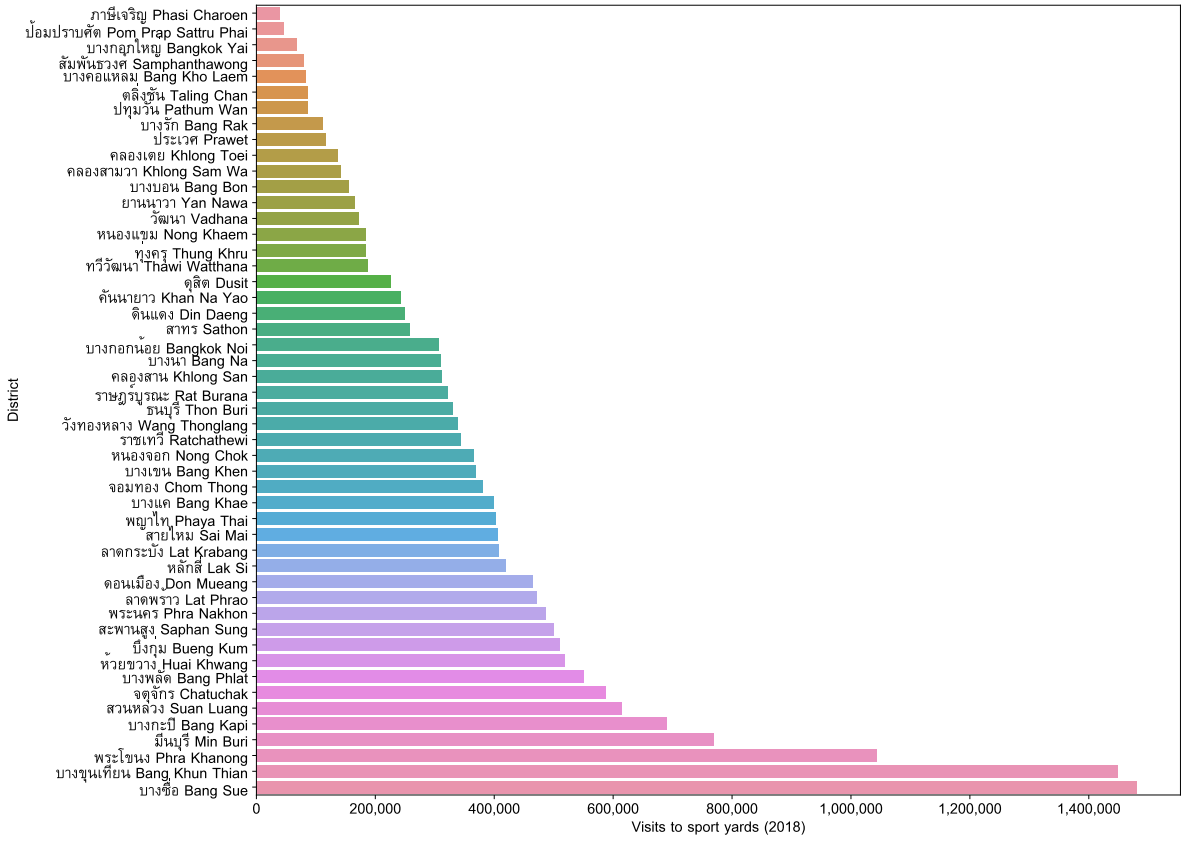


Fig. 408: Districts ranked in ascending order by sport yard visits with regard to visits to sport yards (2018).

Visits to sport yards (2018) per 1,000 population

The number of visits to sport yards within each district was recorded. The indicator was rated as the rate per 1,000 population.

Aligns with Sustainable Development Goals: 2.1, 3, 11.

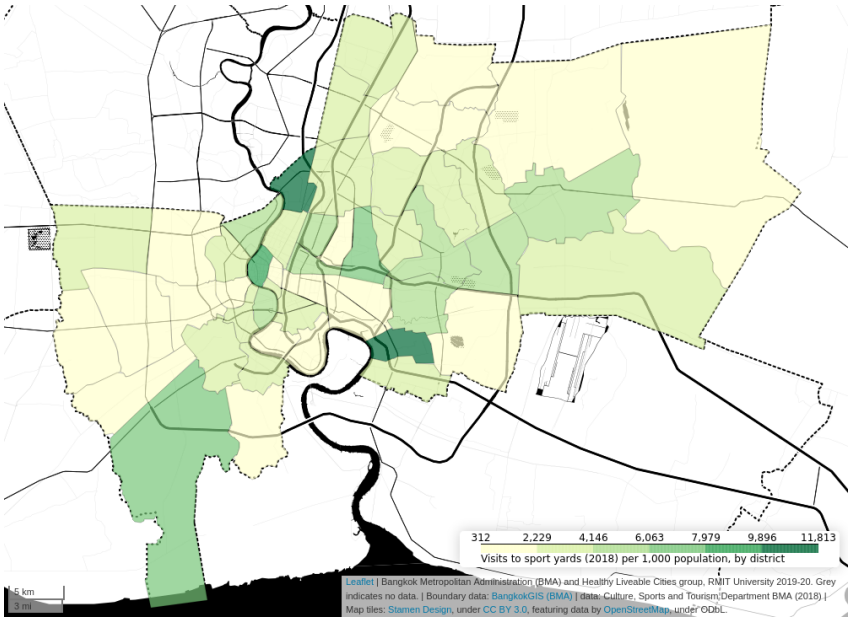


Fig. 409: Visits to sport yards (2018) per 1,000 population, by district

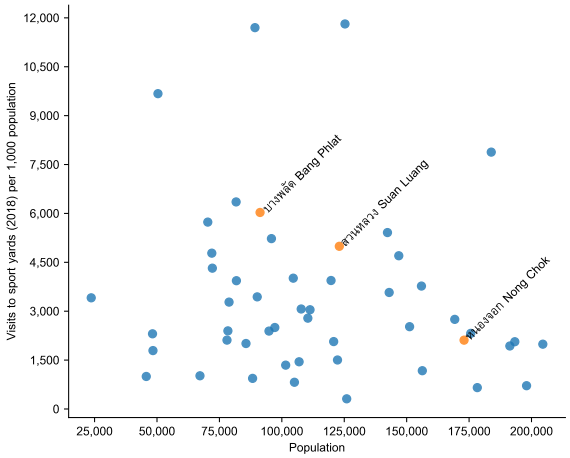


Fig. 410: Scatterplot of Sport yard visits by population for districts.

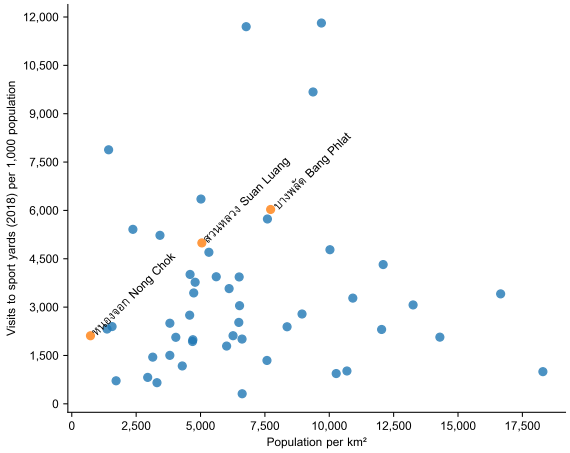


Fig. 411: Scatterplot of Sport yard visits by population density for districts.

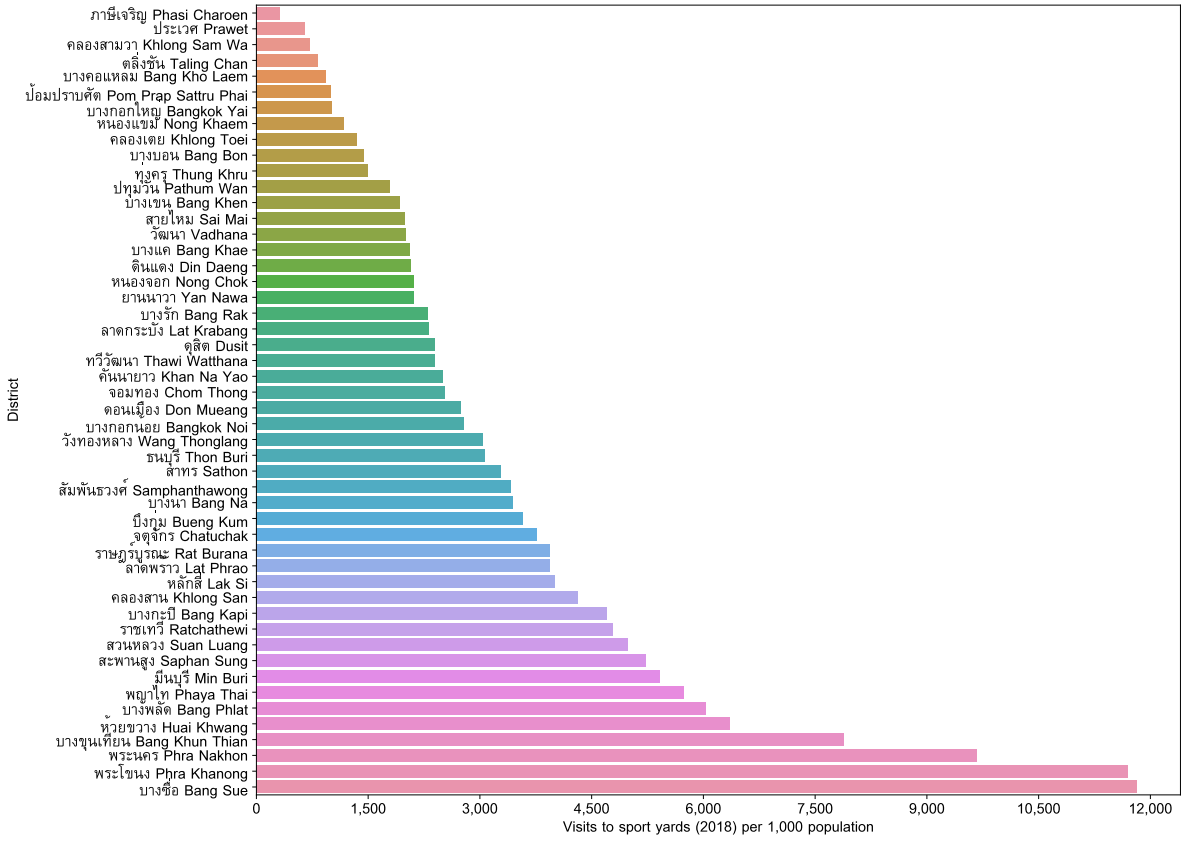


Fig. 412: Districts ranked in ascending order by sport yard visits with regard to visits to sport yards (2018) per 1,000 population.

2.5.6 Opportunity to earn a fair wage

โอกาสในการมีรายได้จากการทำงานอย่างยุติธรรม

Wage means the money agreed upon by an employer and employees to be paid in compensation for normal working hours according to the employment contract. The wage may be paid on a periodic basis, or according to the work done by the employee during normal working hours of the working day. The wage includes the money that an employer pays to an employee on holidays and days off for which the employee does not work. Fair wage means the wage rate for an employee under the national wage laws, such as the minimum wage, overtime pay, holiday pay, social security payment, etc. Cost of living means the cost of a person or goods used to purchase goods and services according to the type and quantity needed for living, such as home expenses.

Dataset: Poverty Indicators 2017

The data table "Poverty Indicators 2017: Cost Dimensions with records for Bangkok overall, districts, and subdistricts" was retrieved from the Thai National Statistical Office (NSO). Data were cleaned for processing and aligned with area IDs.

Data source: `National Statistical Office`

URL: `http://www.nso.go.th/sites/2014/DocLib8/2560/central/urban/10_bangkok.xls`

Publication year: `2018`

Target year: `2017`

Acquisition date (yyyymmdd): `20180121`

Licence: `none specified`

Date type: `numeric`

Scale / Resolution: `area summary`

Notes: `The source data table also includes standard error as a measure of precision for each area estimate`

Data location relative to project folder: `./data/Thai/National Statistical Office/2017 poverty index/NSO_Bangkok_2017_poverty_index_en_cleaned.xlsx`

Average monthly cost of living per person (Baht; 2017)

The average monthly cost of living per person within each analysis area was recorded.

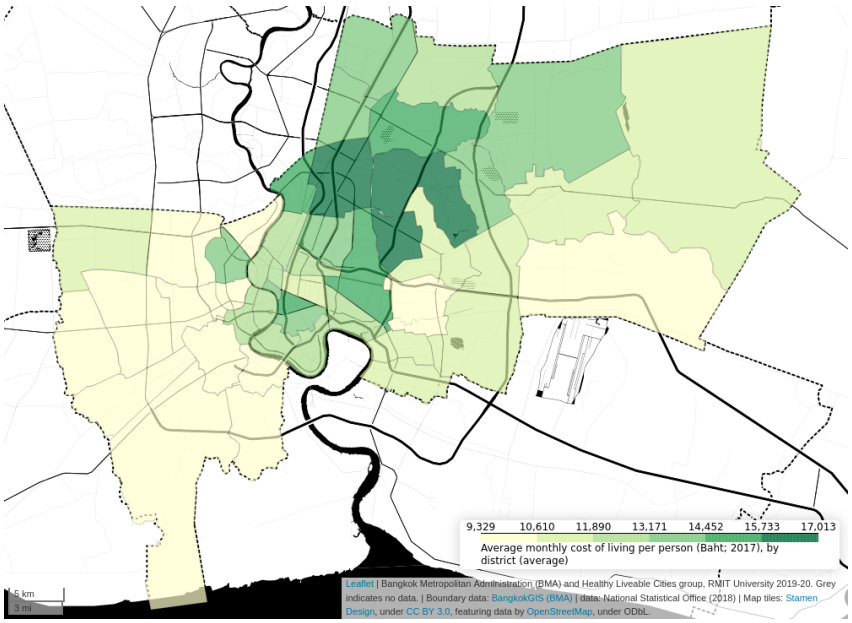


Fig. 413: Average monthly cost of living per person (Baht; 2017), by district

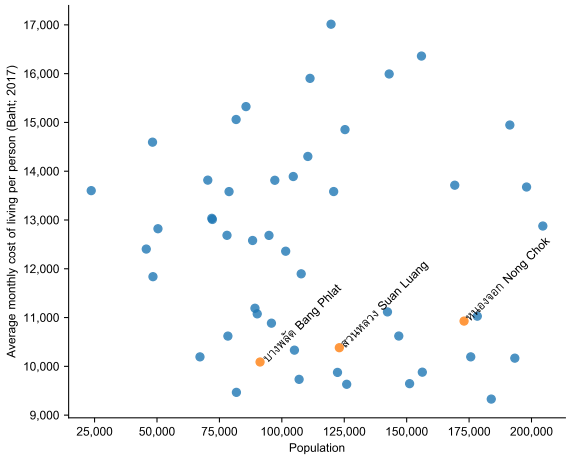


Fig. 414: Scatterplot of Average monthly cost of living per person (Baht; NSO, 2017) by population for districts.

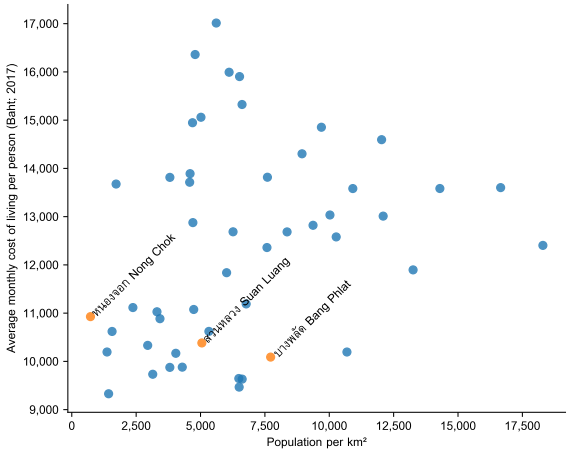


Fig. 415: Scatterplot of Average monthly cost of living per person (Baht; NSO, 2017) by population density for districts.

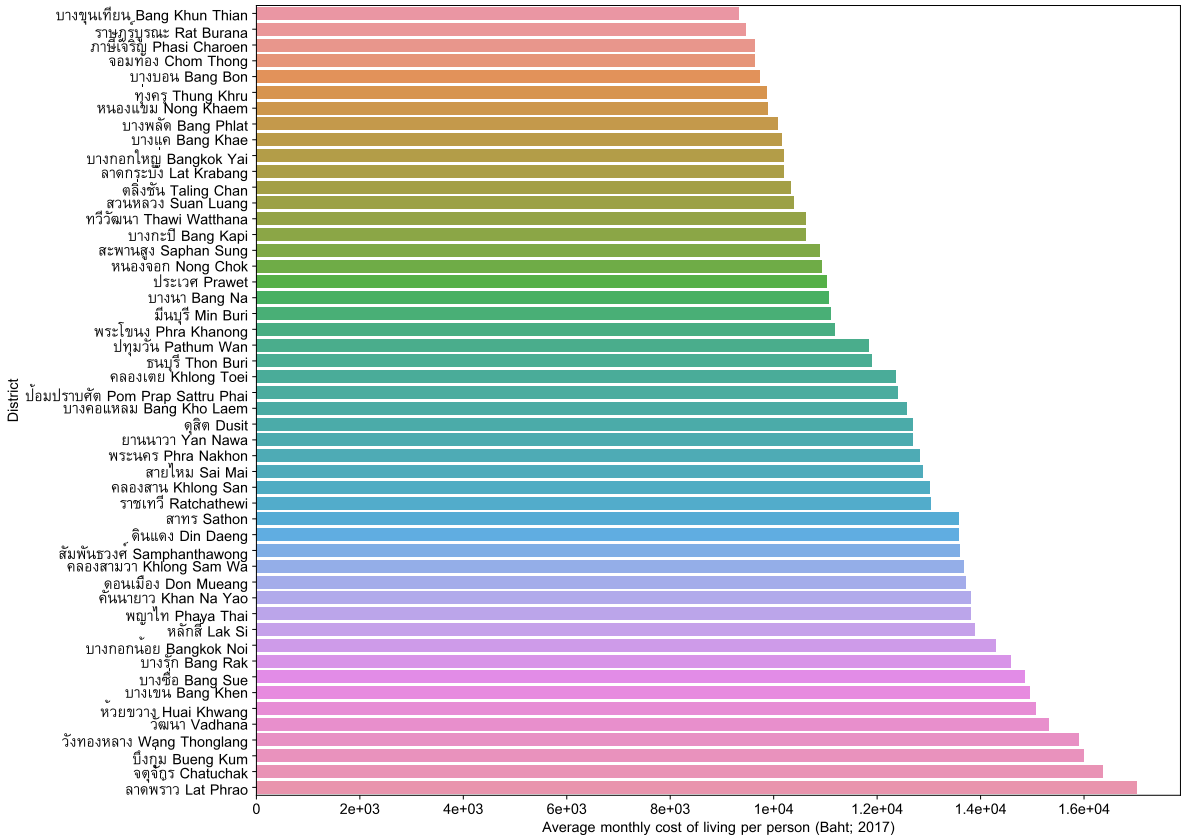


Fig. 416: Districts ranked in ascending order by average monthly cost of living per person (baht; nso, 2017) with regard to average monthly cost of living per person (baht; 2017).

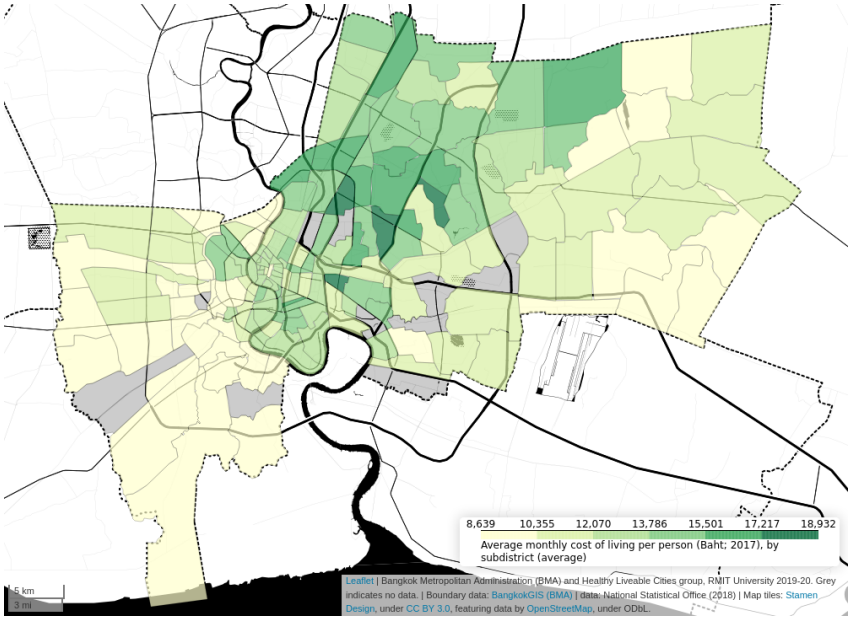


Fig. 417: Average monthly cost of living per person (Baht; 2017), by subdistrict

2.6 Social development

2.6.1 Opportunity to earn a fair wage

โอกาสในการมีรายได้จากการทำงานอย่างยุติธรรม

Wage means the money agreed upon by an employer and employees to be paid in compensation for normal working hours according to the employment contract. The wage may be paid on a periodic basis, or according to the work done by the employee during normal working hours of the working day. The wage includes the money that an employer pays to an employee on holidays and days off for which the employee does not work. Fair wage means the wage rate for an employee under the national wage laws, such as the minimum wage, overtime pay, holiday pay, social security payment, etc. Cost of living means the cost of a person or goods used to purchase goods and services according to the type and quantity needed for living, such as home expenses.

Dataset: Poverty Indicators 2017

The data table “Poverty Indicators 2017: Cost Dimensions with records for Bangkok overall, districts, and subdistricts” was retrieved from the Thai National Statistical Office (NSO). Data were cleaned for processing and aligned with area IDs.

Data source: `National Statistical Office`

URL: `http://www.nso.go.th/sites/2014/DocLib8/2560/central/urban/10_bangkok.xls`

Publication year: `2018`

Target year: `2017`

Acquisition date (yyyymmdd): `20180121`

Licence: `none specified`

Date type: `integer`

Scale / Resolution: `area summary`

Notes: The source data table also includes standard error as a measure of precision for each area estimate

Data location relative to project folder: ./data/Thai/National Statistical Office/2017 poverty index/NSO_Bangkok_2017_poverty_index_en_cleaned.xlsx

Coefficient of inequality (2017)

The coefficient of inequality within each analysis area was recorded. Also known as the Gini coefficient, this is defined as a ratio between 0 and 1 and is here expressed as a percentage. A low Gini coefficient is suggestive of equality in income distribution. Higher values are indicative of an increasingly disparate income distribution. Expressed as a percentage, 0 means absolute equality (Everyone has the same income) and 100 means complete inequality. The Gini coefficient calculation is based on the assumption that no one has a lower income than zero.

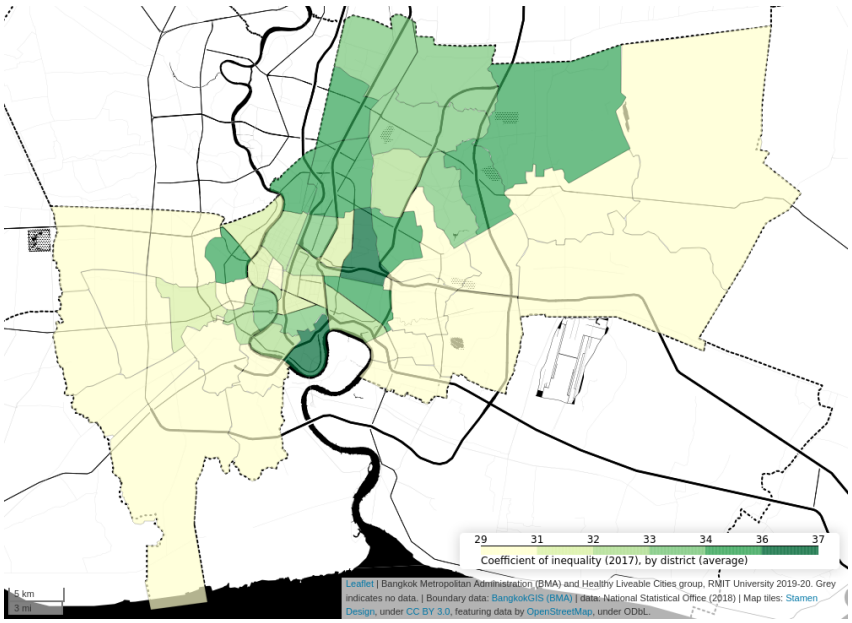


Fig. 418: Coefficient of inequality (2017), by district

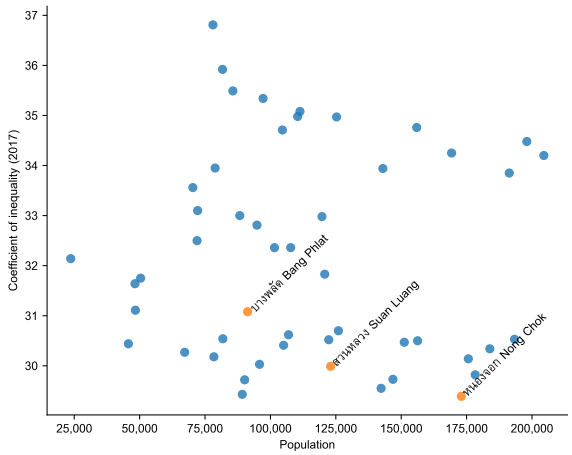


Fig. 419: Scatterplot of Coefficient of inequality (NSO, 2017) by population for districts.

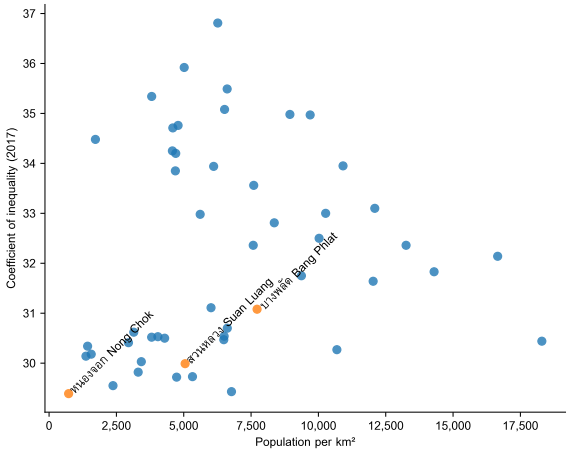


Fig. 420: Scatterplot of Coefficient of inequality (NSO, 2017) by population density for districts.

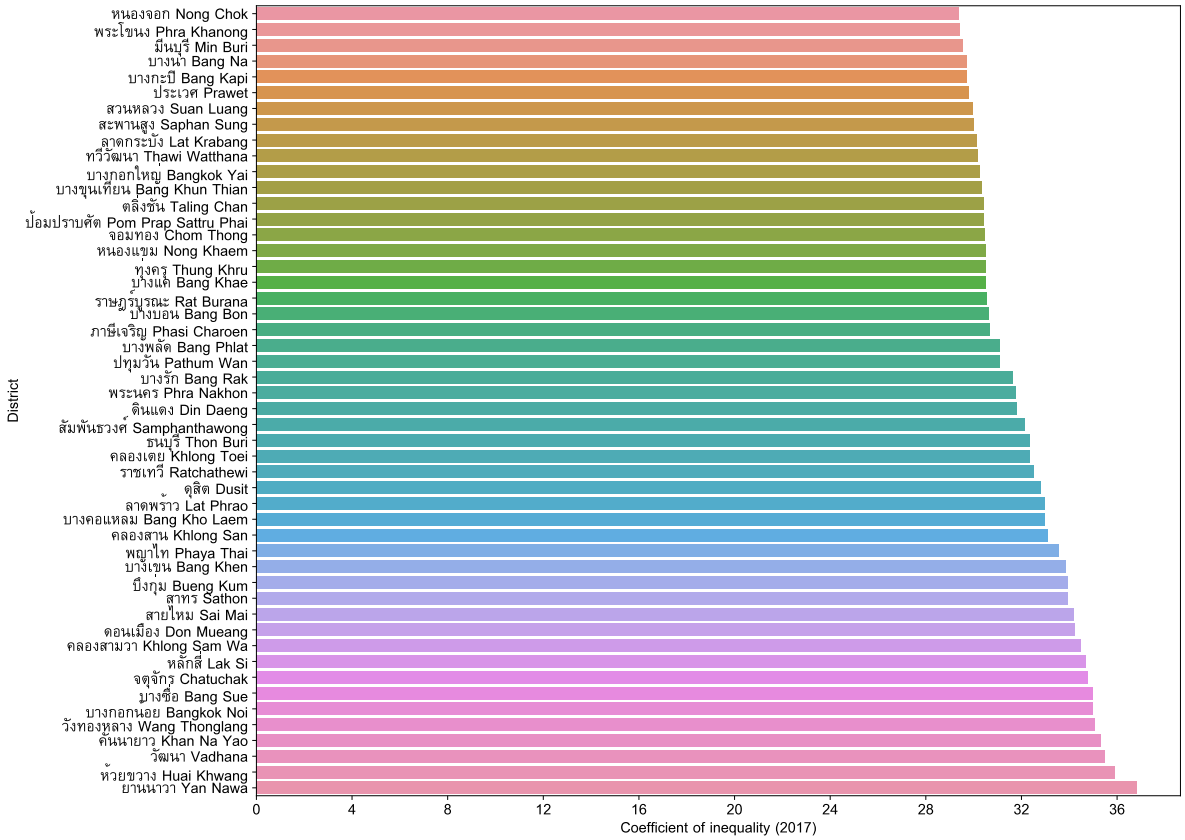


Fig. 421: Districts ranked in ascending order by coefficient of inequality (nso, 2017) with regard to coefficient of inequality (2017).

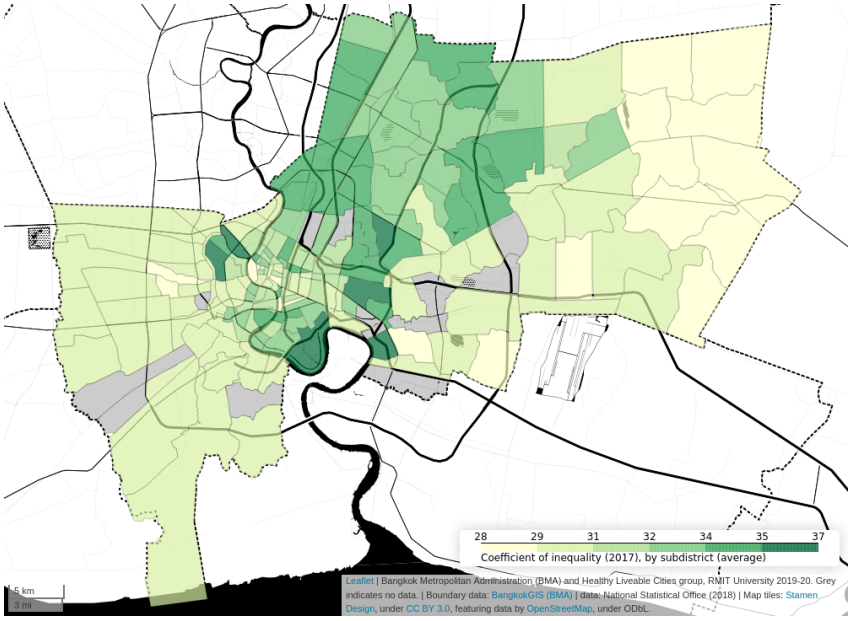


Fig. 422: Coefficient of inequality (2017), by subdistrict

2.6.2 Local employment opportunities

โอกาสในการทำงานในท้องถิ่น

Local job opportunities mean that the people living in an area can expect or assess whether there will be work in that area where they live.

Dataset: Taxes collected

Data at district level were prepared by the Bangkok Metropolitan Administration and supplied as an Excel workbook. The data comprised sample point records of actual revenue by taxes collected by BMA district offices for the fiscale year of 2019, source dfrom the BMA Finance Department in October 2019. Data were cleaned for processing and aligned with area IDs.

Data source: `Finance Department, BMA`

Publication year: `2019`

Target year: `2019`

Acquisition date (yyyymmdd): `20190617`

Licence: `none specified`

Date type: `float`

Scale / Resolution: `area summary`

Data location relative to project folder: `./data/Thai/_from BMA/20191204/transfer_1815206_files_409fa2da/BKK_taxes_district_19 _kn20191201.xlsx`

The percentage contribution of local taxes to overall BMA tax revenue (2019)

The percentage contribution of local taxes to BMA's overall tax revenue for 2019 was calculated by dividing the total revenue for each district (sum of house and building taxes, local development taxes, and signboard taxes) by the contribution from local deveopment taxes and multiplying this by 100.

Aligns with Sustainable Development Goals: 3, 6, 9, 11, 12, 14.

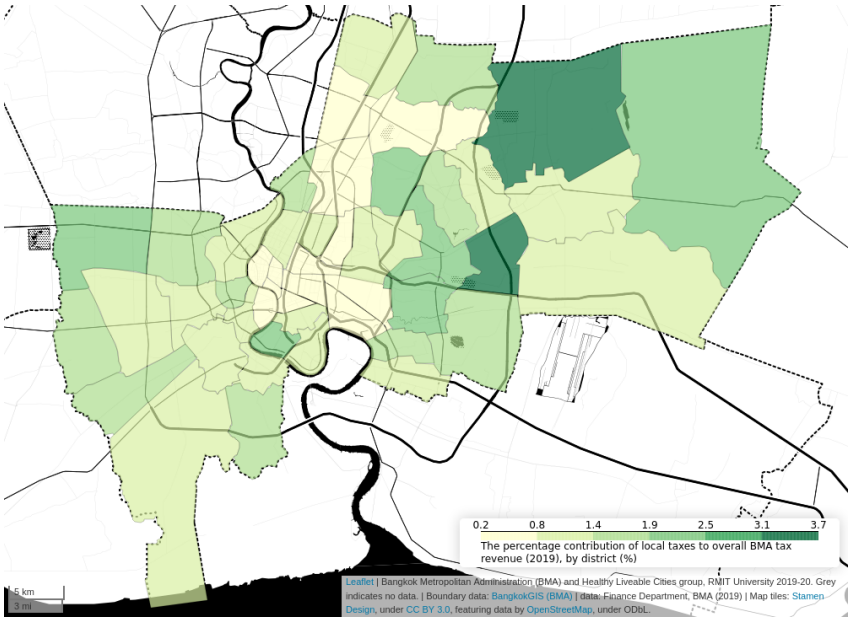


Fig. 423: The percentage contribution of local taxes to overall BMA tax revenue (2019), by district

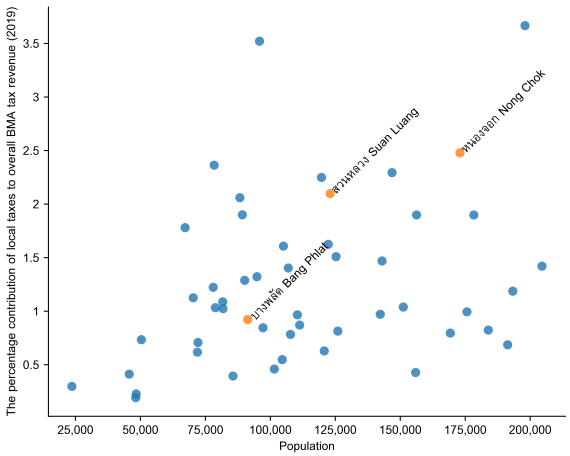


Fig. 424: Scatterplot of Local Development Taxes by population for districts.

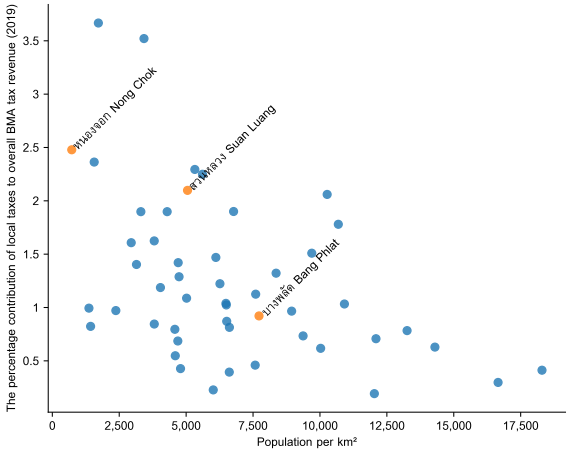


Fig. 425: Scatterplot of Local Development Taxes by population density for districts.

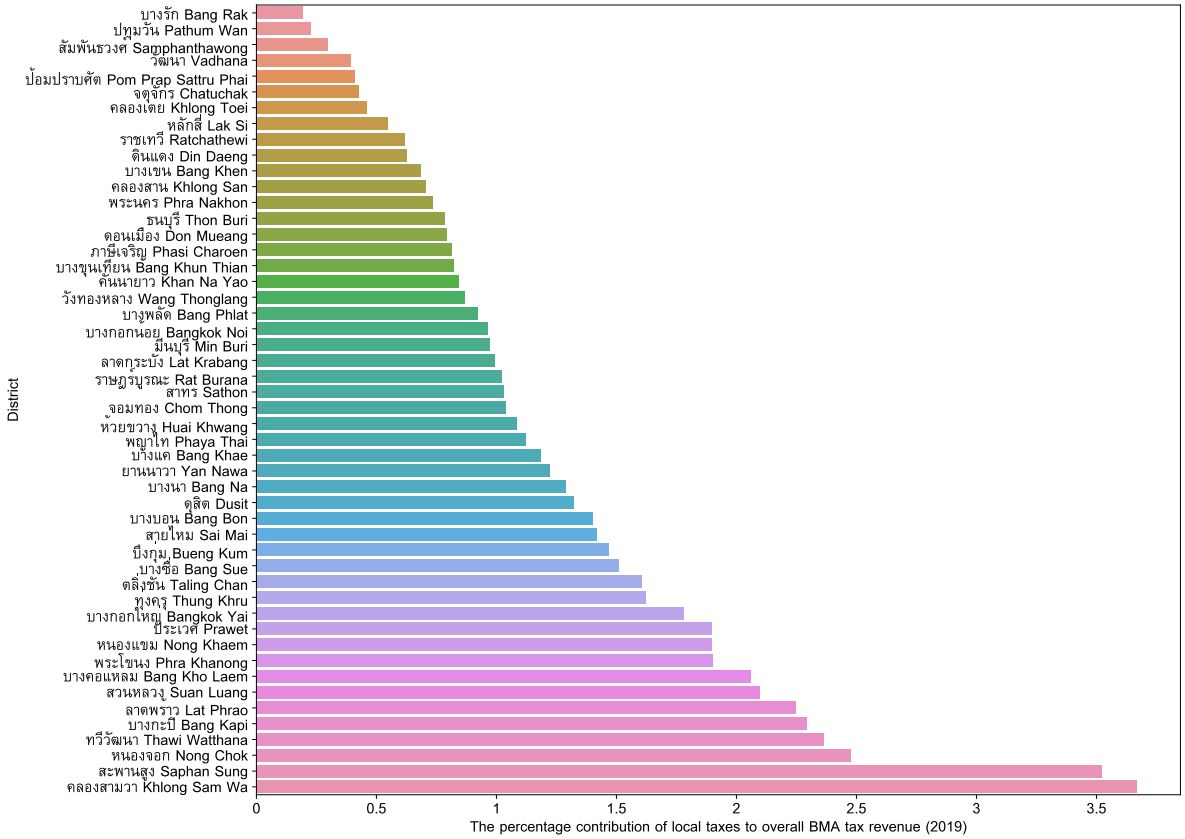


Fig. 426: Districts ranked in ascending order by local development taxes with regard to the percentage contribution of local taxes to overall bma tax revenue (2019).

2.7 Interactive maps

Interactive maps for indicators were created and are browsable using the html documentation.

CHAPTER

THREE

TECHNICAL DOCUMENTATION

3.1 Installation

To install and run the software framework for calculation and output of the Bangkok liveability indicators in a variety of formats, the user must first ensure that the following software, code, and data requirements are met.

3.1.1 Software requirements

Windows subsystem for linux (WSL)

On a computer running Windows 10, we first set up Windows subsystem for linux (WSL) by running the following in PowerShell in Administrator mode:

```
dism.exe /online /enable-feature /featurename:Microsoft-Windows-Subsystem-Linux /
↪all /norestart
```

Optionally, the user may install the newer version of WSL2 by following the additional directions provided at the link above. Once ready, the computer should be restarted.

Ubuntu

Ubuntu may be installed for Windows as per the instructions at this link. Ubuntu provides a command line operating system for installing and running the open source software suite curated for this project.

Git

Git is software used for distribution and version tracking of software projects. Please download and install this software for your platform from the provided link. This is required in order to retrieve the Bangkok liveability code.

Docker

Docker is a tool which facilitates installation of a raft of other required software, all at once while helping to ensure compatibility between different software versions. Follow the provided link to download the version of Docker Desktop appropriate for your platform.

When ever the project is to be run, Docker Desktop must be running as a background service on the user's computer. If Docker is running, there should be the icon of a whale in the user's taskbar on Windows 10; if the cursor is hovered over this, it should say, 'Docker Desktop is running'.

3.1.2 Spatial indicator framework for Healthy, Liveable Bangkok

The code for running the Bangkok liveability analyses is hosted in a Git repository. At the time of writing (16 October 2020) this is hosted in a private Bitbucket online repository, and so for now access must be granted manually. The code is provided under an MIT licence however, and will be made officially public via GitHub in tandem with publication of project methods.

To retrieve the repository, in a command window in the parent directory to where you would like the project to be located type:

```
git clone https://carlhiggs@bitbucket.org/carlhiggs/ind_bangkok.git
```

This should create the project directory 'ind_bangkok' along with a series of subfolders, including the folders 'data' (in which the data retrieved in the following step should be stored), and 'process' which contains the code required to run the project analyses.

Initialise project spatial database

The project database is stored using a seperate Docker container which is used to run the SQL database software PostgreSQL with the spatial extension PostGIS. This is the immediate location where indicators and spatial data are stored once processed. Mapping programs like QGIS may connect to this database in order to map indicators, once processed.

The database is set up by running the command *initialise_database* from the the Windows command line in the project's parent directory (the "ind_bangkok" folder). This will most likely only need to be done once, at project commencement, after which the database docker image should persist locally when Docker is running.

This launches the *initialise_database.bat* batch file, which is a text document containing code which directs the computer to

- retrieve the *cityseer/postgis* Docker image
- create a database container for running Postgis called *pg_spatial* with user 'hlc' and password 'huilhuil!42'.

The default username and password may be changed in the batch file before running using a text editor to edit it; however, if these are modified they should also be changed in the project configuration parameters, as described later in the setup process.

Launch the spatial analysis processing environment

With the software pre-requesites installed and running, and the code repository constructed in a project folder, the curated open source software framework for calculation of spatial indicators (the *ind_bangkok* "container") may be installed by typing and entering *ind_bangkok* from the project parent directory (the "ind_bangkok" folder) at the Windows command prompt.

This launches the *ind_bangkok.bat* batch file, which is a text document containing code which directs the computer to

- pull the latest version of the project code
- retrieve the latest version of the *carlhiggs/ind_bangkok* docker image, if not presently installed
- launch the *ind_bangkok* docker container, which provides a Unix command prompt for running the project software

If you close the terminal window in which the the spatial analysis processing container is running, it remains active in the background as long as the Docker service is running (e.g. until the computer is shut down). To return to the command prompt from the *ind_bangkok* container, but still leave it running, you can also press Ctrl+p+q . To return to the container from the prompt you can enter *docker attach ind_bangkok*. Finally, to stop the container altogether, you can enter *docker stop ind_bangkok*.

3.1.3 Data requirements

The collated input data used to create the baseline suite of Bangkok liveability indicators has been uploaded to a private CloudStor data repository for the moment. This contains international and Thai sourced data, including data provided directly by the Bangkok Metropolitan Administration.

At the time of writing, the data may be accessed from the provided link using the access word *BangkokLiveability@2020*

Once downloaded, the contents of the zipped folder should be extracted and located within the projects 'data' directory.

3.1.4 Additional notes

- Try to allocate at least 8Gb (> 8000mb) memory in the advanced settings of Docker Desktop (more than 2Gb, the default, is required; 8Gb works)
- If you find the database has stopped (a warning will be raised when running the scripts that the database doesn't exist), try "docker start pg_spatial" to re-start it if you re-run 'initialise_database.bat', this will mean you will have to re-run code to re-create and re-build the database — so that is probably something you only want to do at project commencement
- Occasionally you might find that the Docker Desktop application doesn't run successfully the first time you launch it; if so, try restarting the application, and it will likely resolve the issue.

3.2 Project configuration

Before commencing analysis, the project must be configured using the Excel file located relative to the project directory (.) at *./process/_project_configuration.xlsx*.

In addition to containing project and study region specific parameters which are used by the scripted process, it also provides a a catalogue of project resources.

The content of the *Parameters* and *Resources* sheets is used to respectively determine the overall project settings, and how specific indicator measures are calculated.

3.2.1 Parameters

New study regions can be added as columns in the *Parameters* worksheet, by copying an existing study region (e.g. Bangkok, or Bang Phlat) and modifying the parameter values as required. Some parameters are technical and unlikely to be used, however descriptions of each have been provided, and the parameters most likely to require modification have been highlighted. Each study region must have a unique lower case name with no spaces or special characters in the column heading, as this is used as a code to refer to the study region during processing and assignment of resources for the region.

3.2.2 Resources

The *Resources* sheet provides a catalog of project resources (rows) aligned with specific usage (for example, for calculating a specific indicator) including key details required for processing including, provenance, currency, licence requirements, storage location, and any usage notes.

The main role of this sheet if for adding new indicator measures as rows in the *Resources* worksheet. Each column field may be customised to determine the kind of indicator. Customisable column attributes are detailed in full in the *About* worksheet, however include:

- its *dimension* and *category* according to the Bangkok liveability framework, and matching the definitions in the *Bangkok context definitions* worksheet.

- *indicator_measure* is the plain language name of the indicator
- *region* is the study region (as defined in *Parameters* under *full_locale*, e.g. "Bangkok") for the indicator
- *type* is the type of indicator this will be, primarily determined by its data source: 'linkage' (linkage of area level estimates using an Excel spreadsheet with standard formatting), 'raster' (area summary of a raster dataset such as satellite imagery), or accessibility (percent of population with estimated access to an amenity based on network analysis using either OpenStreetMap or custom spatial data)
- the location of the *data_file* to be used relative to the project directory
- the *areas* to be summarised (using seperately defined resources with *purpose* of "boundaries")
- and other attributes including metadata on methods and data source details, and how to map the indicator measures

Usage examples for how to prepare each of the three types of indicator (linkage, raster, and accessibility) will be provided in the webinar resource.

3.3 Methods

With the project requirements met, software installed, code and project directories retrieved, input data downloaded, and project configured with a study region and indicators defined, we are now ready to commence analysis!

To launch the ind_bangkok computational environment on a Windows 10 computer, type *ind_bangkok* at the command line in the ind_bangkok project's root directory. This will launch into the Spatial indicator framework software environment, at a unix shell (command line) prompt.

Once the container has loaded, type *cd process* to move into the process folder. This contains text files containing code which are used to complete various tasks.

There are two kinds of processing files, those which relate to setting up the resources required in order to calculate indicators and which are numbered sequentially, and those which draw upon the resources previously set up in order to calculate indicators or output their associated documentation and which have an underscore prefix.

3.3.1 Setting up resources

These scripts are intended to be run sequentially. However, if accessibility indicators are not required it may be sufficient to just run the first three scripts to establish the database, study region boundaries, and population statistics which linkage or raster indicators may draw upon.

The scripts are run by typing *python <script> <study region>*; for example

```
python 00_create_database.py bangkok
```

However, as Bangkok is the default study region, its name may be omitted and the program will assume that this is the study region being referred to and configure the code accordingly.

00_create_database.py

Initialises a PostgreSQL database and related settings for creation of liveability indicators for a particular study region.

01_create_study_region.py

Establishes study region boundaries and associated population resources, as defined in the *Parameters* and *Resources* worksheets in *_project_configuration.xlsx* for this study region.

02_create_population.py

This imports area level population estimates (as defined in the *Parameters* and *Resources* worksheets in *_project_configuration.xlsx*) into the project database and produces basic population map file outputs which will be included in the final report documentation.

3.3.2 Optional resource setup for accessibility analyses

03_create_osm_resources.py

Collate OSM resources for specified study region, as defined in the *Parameters* and *Resources* worksheets in *_project_configuration.xlsx*.

04_create_network_resources.py

Derive a walkable network for pedestrians derived from OpenStreetMap data using OSMnx

05_open_space_areas_setup.py

Prepare a dataset of areas of open space (public parks and squares), derived from OpenStreetMap data, as configured in the *osm_open_space* worksheet in the *_project_configuration.xlsx* file.

06_create_sample_points.py

Create sample points at regular intervals along the pedestrian street network for use in sampling accessibility to destinations.

07_compile_destinations.py

Compile a schema of destination features either using custom data, or OpenStreetMap. Custom destination data sources are defined in the *Resources* worksheet in *_project_configuration.xlsx* with *purpose* of "destinations" and *type* equal to the *variable_name* of the destination's corresponding accessibility indicator they are to be used for measuring. OpenStreetMap destinations are defined in the *osm_destinations* worksheet in *_project_configuration.xlsx* file.

08_accessibility_analysis.py

Undertake accessibility analysis within threshold distance for defined destination access indicators. The threshold distance is defined using the *resolution* parameter in the *Resources* worksheet in the *_project_configuration.xlsx* file for a row with *purpose* of "indicator" and *type* of "access".

3.3.3 Creating indicators

The following code files each collate resources in the database and output map files (images, and interactive html files) which may be used in reporting, and CSV data files for upload to the web portal. These are saved to a study region specific folder located within the project *output* directory, drawing on the indicator measure definitions established in the *Resources* worksheet in the *_project_configuration.xlsx* file.

_create_linkage_indicators.py

Running this command will process resource rows with purpose of 'indicator' and type of 'linkage' which have a defined data source and method. The linkage data set should have an identifier corresponding to the boundary data. There are a number of settings which can be used to determine how the indicator is to be calculated (e.g. it may be linked directly, or used to derive a rate per sqkm or per amount of population or households, or all of these). If more than one value exists per linkage area in the dataset, there is the option of how to aggregate these (e.g. count, sum, average). In addition, linkage indicators may be formed as a function of multiple columns (e.g. a ratio or sum of two fields for a particular area).

_create_raster_indicators.py

Create indicators from raster data sources based on aggregation to polygon area boundaries, defined in the *Resources* section of configuration file.

_create_accessibility_indicators.py

Create indicators based on previously run accessibility analyses

3.3.4 Comparison plots

_render_plots.py

Scatterplots and barplots of indicator results across regions can be generated as a supplement to maps for viewing results. This is achieved by setting the value of the *plot* column in the *Resources* worksheet for a particular defined indicator to an area extent (e.g. "district" or "subdistrict"). If *regions_of_interest* has been defined in the *Parameters* worksheet, the generated scatterplots will have label annotations for these regions if they correspond to values matching the *regions_of_interest_variable*.

3.3.5 Creating documentation

_create_documentation.py

Following calculation of indicators, which generates a set of outputs for the study region in the project *output* folder, documentation for project progress to date may be generated in html and PDF format drawing upon individual indicator outputs using the command:

```
python _create_documentation.py bangkok
```

There is an optional *technical_documentation* parameter in the *Parameters* worksheet of the configuration file, which may be set to True or False to determine whether the Technical documentation section detailing software installation, running, and methods will be included, or not.

Depending on the number of indicators processed, the compilation of the PDF report may a few take minutes to complete.

3.3.6 Spatial indictor framework outputs

When the scripts described in the *Creating indicators* section above are run, various file outputs are created in the project *output* directory under a subfolder for the study region being processed (by default, 'bangkok_thailand_2018').

Indicator data are output in a series of formats as a result of running the Bangkok Liveability scripted process. These are represented by a series of folders for each output format, as described below. In addition, if the *_create_documentation.py* script has been successfully run, there should also exist a named and dated documentation PDF report in the output folder for the study region.

3.3.7 Documentation

The 'docs' folder contains a project documentation website which may be accessed by opening the file index.html in a web browser. In addition, a PDF version of the project documentation is also generated in the project output folder.

3.3.8 CSV

The 'csv' folder contains comma seperated values (CSV) files with indicator data referenced by an area level identifier. These follow a template designed for uploading data to the proposed indicator portal, linking up with geojson boundaries for mapping. The naming convention for the files includes the study region, the variable name, the area scale, and if applicable any further details on scaling of the data as a rate.

3.3.9 Geojson

The 'geojson' folder contains geojson files which may be used to represent the spatial boundaries of province, subdistrict and district areas for Bangkok. These are intended to be used for mapping and linkage purposes with the proposed indicator portal.

3.3.10 Geopackage

The 'gpkg' folder contains a geopackage file which is a database containing spatial boundaries and linkage files. Province, subdistrict and district boundaries associated with population and community indicators are included, as well as additional indicator tables which can be joined on via linkage on using the area ID variables. These can be used for mapping, for example using the open source software package QGIS.

3.3.11 HTML

Interactive 'preview' web maps of indicators are produced at district and subdistrict level as stand-alone html files. Named according to the indicators they depict, these files may be opened in a web browser such as Chrome or Firefox. On hover, in addition to the specific indicator the file relates to additional population and community statistics are displayed. There are two different kinds of base maps (simple, and OpenStreetMap), which may also be switched off to display the map with a plain background. There is also an optional layer for place names.

3.3.12 PDF

A 'plots' subfolder in this directory contains scatter plots and horizontal box plots for comparing results across areas.

3.3.13 PNG

These are static maps of indicators, with legend, attribution, scale and a basic basemap of the study region.