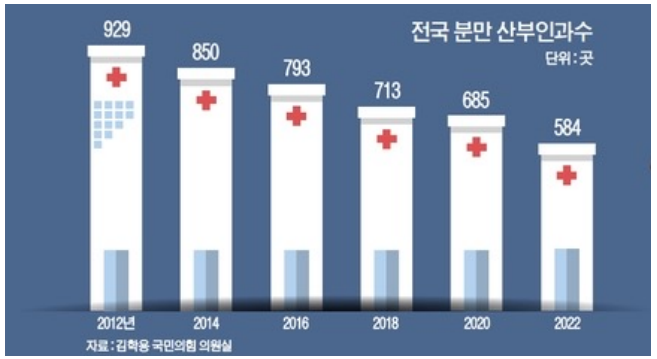
Analysis of obstetrically underserved area

24-1 Python Programming

김현서 | 양인성 | 이정한 | 이호준 | 장기호

South Korea's critically low birth rate and regional facility closures necessitate a new, comprehensive approach to identifying and supporting childbirth-vulnerable areas.

I. Overview of the Study 1. Background and Objectives of the Study



- South Korea's 2022 fertility rate is 0.78, the lowest in the world.
- This low birth rate accelerates population decline and regional extinction.
- Closure of delivery rooms and obstetric facilities in provincial areas has increased, with a 34.4% decrease since 2013.
- Reduced delivery facilities create significant regional disparities in childbirth services.
- The Ministry of Health and Welfare's criteria for vulnerable areas focus only on accessibility and utilization, neglecting the number of delivery room beds and birth rates.
- A new approach is needed to include these factors for a more comprehensive assessment and better policy support.

Identification of childbirth vulnerable municipalities is based on delivery room ratios to women aged 25-39 and birth rates, using spatial analysis methods like Buffer and 2SFCA with 2022 data.

I. Overview of the Study 2. Contents and Methods of the Study

- **Selection of Vulnerable Areas at the Provincial Level:**

- Delivery Room Ratio to Women Aged 25-39

: Number of delivery rooms per region / Number of women aged 25-39 per region.

- Delivery Room Ratio to Birth Rate

: Number of delivery rooms per region / Birth rate per region.

<Comparison Table of Criteria>

선정기준	보건복지부	파이썬 프로그래밍 1조
60분 이내 도달 가능한 분만실 개수	O	O
60분 이내 분만의료 이용률	O	X
25-39세 가임인구 대비 분만실 개수	X	O
지역별 출산율 대비 분만실 개수	X	O

- **Identification at the county Level:**

- Buffer: Visualize a 20km radius around hospitals with delivery rooms.
- 2SFCA: Utilize Open Street Map road network data with the following criteria:
  - Demand: Number of women aged 25-39 per municipality.
  - Supply: Number of delivery rooms per hospital.
  - Travel: Distance from the center of each municipality to the delivery service points.

Jeonnam was identified as a childbirth vulnerable province based on the delivery room ratio to birth rate and the delivery room ratio to women aged 25-39.

II. Analysis of Indicators for Childbirth Vulnerable Areas

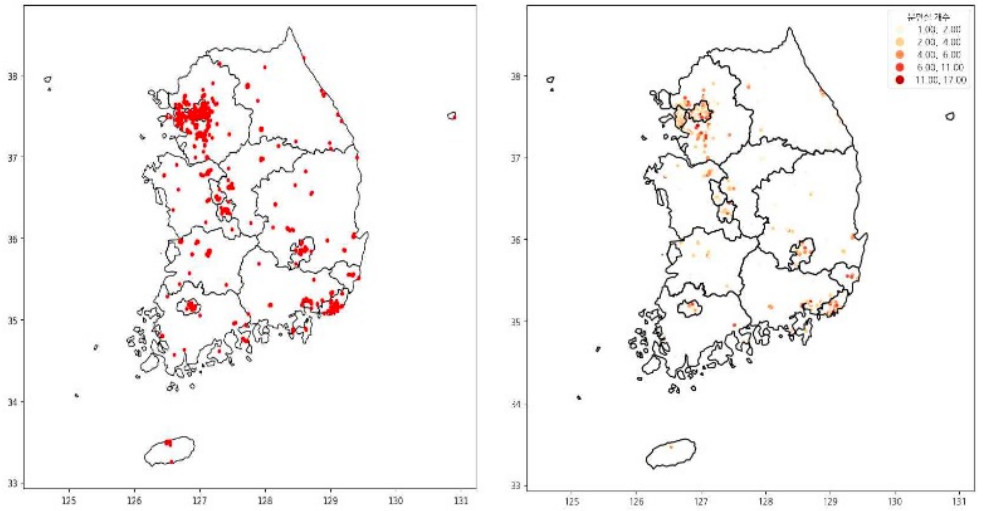
1. Selection of Childbirth Vulnerable Areas

<Delivery Room Ratio to Birth Rate>

시군구명	합계 출산율	출산율 대비 분만실 병상수
전남 영광	1.80	0.55
강원 양구	1.43	0.69
강원 철원	1.39	0.71
경북 예천	1.15	0.86

- Provinces with municipalities having bed counts below 1 relative to birth rates: Jeonnam (4), Gangwon (2), Gyeongbuk (2), Chungbuk (1).

< Delivery Room Ratio to Women Aged 25-39 >

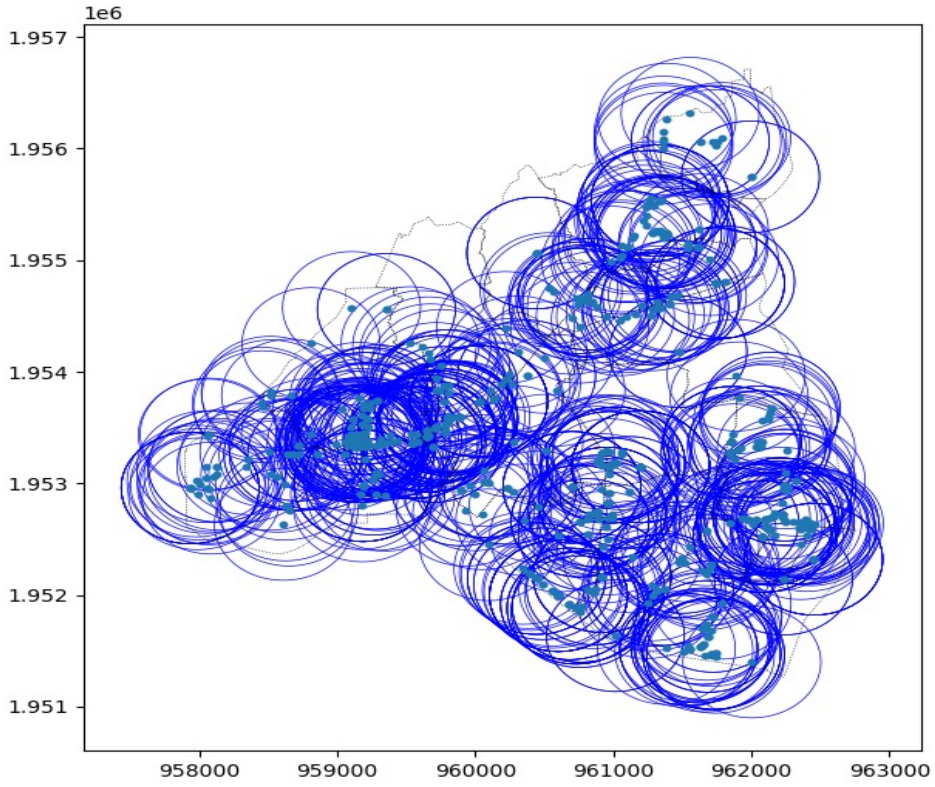


시도명	가임인구(단위: 명)	분만실 수(단위: 개)	만명 당 분만실 수(단위: 개)
전남	123,594	34	2.75
경기	1,349,463	406	3.01
서울	1,129,776	358	3.17
광주	135,965	44	3.24

Jeonnam

The buffer analysis method is appropriate for selecting areas vulnerable to delivery in Jeonnam and identifying medical services in those areas.

II. Analysis of Indicators for Childbirth Vulnerable Areas 2. Analysis Methods – (A) Buffer



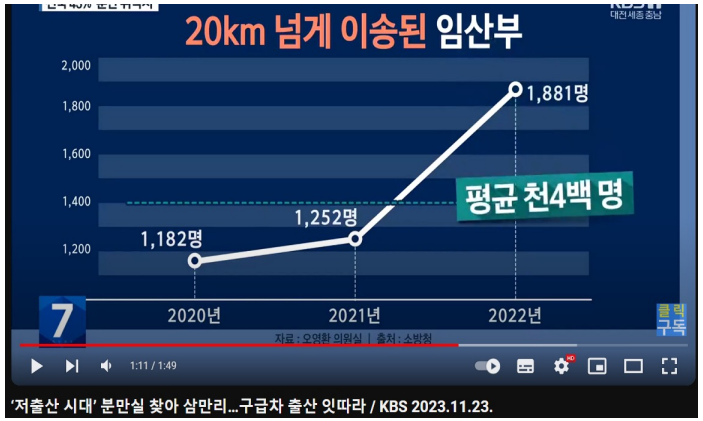
- To calculate and visualize areas within a certain distance around a particular point
- This allows to identify areas affected by a particular point

↓

- Through the aforementioned analysis, We think the buffer analysis method is appropriate for selecting areas vulnerable to delivery as Jeonnam and identifying medical services in those areas

Based on news reports, a 20km buffer around hospitals with delivery beds in Jeollanam-do was set to identify vulnerable delivery areas.

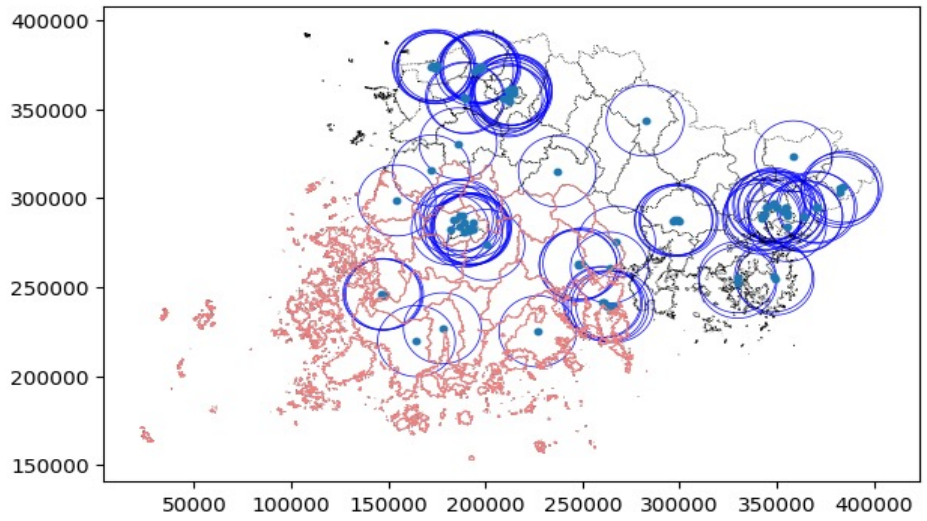
II. Analysis of Indicators for Childbirth Vulnerable Areas 2. Analysis Methods – (A) Buffer

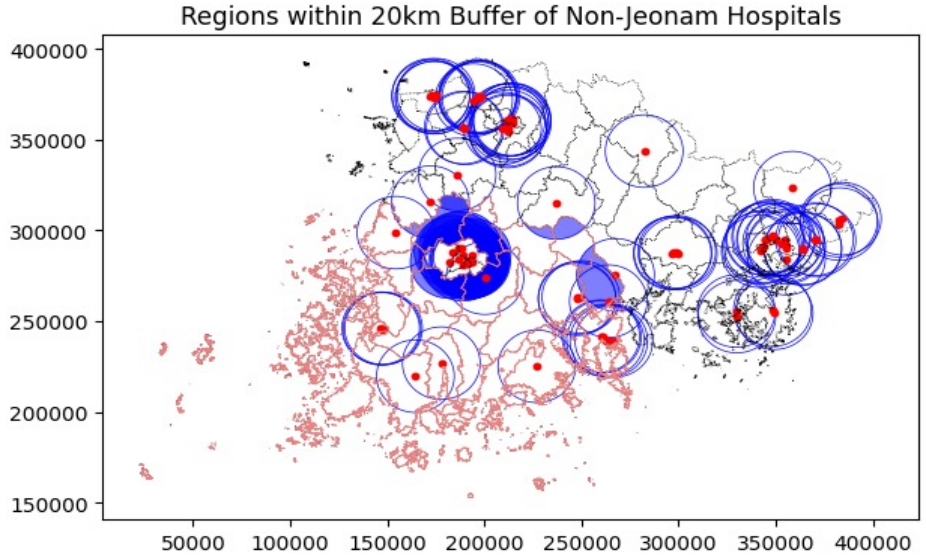


- Think about the radius of the delivery vulnerable area in Jeollanam-do other than the standard of the Ministry of Health and Welfare
- Several news outlets have confirmed that pregnant women are uncomfortable traveling 20 kilometers
- With this in mind, the buffer in the hospital with the number of beds in the delivery room is drawn based on 20km to check the vulnerable areas of delivery in Jeollanam-do

Analyzing the buffer radius of hospitals in Jeollanam-do and neighboring areas and visualizing the accessibility of delivery services in non-Jeonnam areas

II. Analysis of Indicators for Childbirth Vulnerable Areas 2. Analysis Methods – (A) Buffer



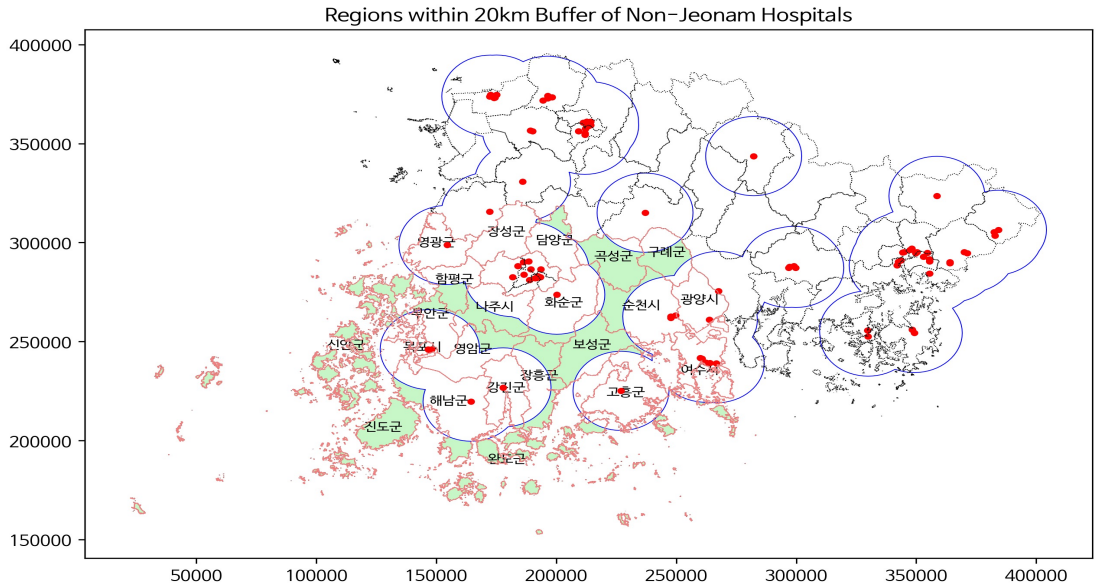


- Identify hospital service areas within the buffer radius in Jeollanam-do and where delivery services are received from non-Jeonnam areas
- Areas that receive delivery medical services outside of Jeollanam-do shall be treated as receiving delivery medical services in Jeollanam-do

Labeling and shading Jeollanam-do areas that are not included in the buffer

II. Analysis of Indicators for Childbirth Vulnerable Areas 2. Analysis Methods – (A) Buffer

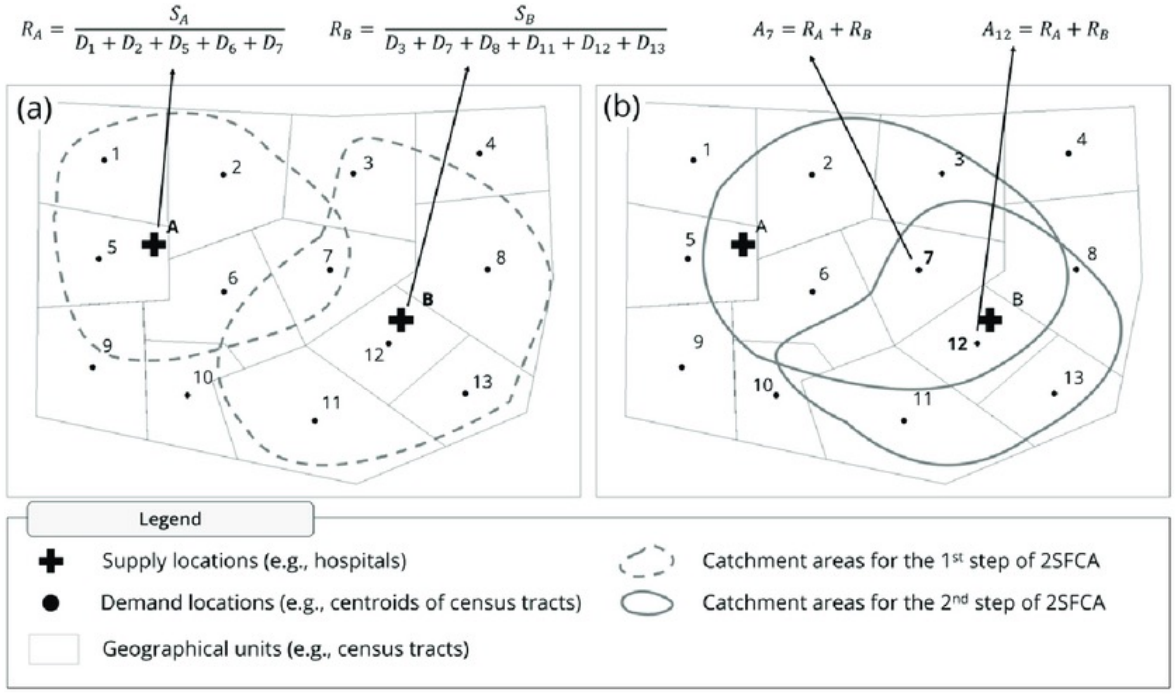
```
buffer_distance = 20000  # 20km

# 병원 데이터 버퍼 생성
Honamhospital_buffer = Honamhospital.buffer(buffer_distance)

# 전남 지역 병원과 다른 지역 병원 분리
Jeonam_hospitals = Honamhospital[Honamhospital.within(Jeonam.unary_union)]
non_Jeonam_hospitals = Honamhospital[~Honamhospital.within(Jeonam.unary_union)]

# 다른 지역 병원의 버퍼 생성
non_Jeonam_hospitals_buffer = non_Jeonam_hospitals.buffer(buffer_distance)

# 전남 지역과 다른 지역 병원의 버퍼가 겹치는 부분 찾기
intersection = non_Jeonam_hospitals_buffer.intersection(Jeonam.unary_union)

# 전남 지역 전체에서 버퍼가 겹치지 않는 부분 찾기
buffered_area_within_jeonam = Jeonam.unary_union.intersection(Honamhospital_buffer.unary_union)
non_buffered_jeonam = Jeonam.unary_union.difference(buffered_area_within_jeonam)

# 시각화
fig, ax = plt.subplots(figsize=(10, 15), dpi=300)  # 해상도 설정

# 전남 지역에서 버퍼가 겹치지 않는 부분을 연한 초록색으로 표시
gpd.GeoSeries(non_buffered_jeonam).plot(ax=ax, color='lightgreen', alpha=0.5, zorder=1)

# 전남 지역과 겹치는 다른 지역 병원 버퍼 부분을 흰색으로 표시
gpd.GeoSeries(intersection.unary_union).plot(ax=ax, color='white', alpha=0.5, zorder=2)

# 병원 버퍼 경계 표시
gpd.GeoSeries(Honamhospital_buffer.unary_union).boundary.plot(ax=ax, color='blue', lw=0.5, zorder

# 병원 위치 표시
Honamhospital.plot(ax=ax, markersize=10, color='red', zorder=4)

# 전체 지도 경계 표시
combined_gdf.boundary.plot(ax=ax, linestyle='dotted', lw=0.5, color='black', zorder=5)

# 전남 지역 경계 표시
Jeonam.boundary.plot(ax=ax, color='lightcoral', linewidth=0.5, zorder=6)

# 전남 각 군의 라벨링 추가
for idx, row in Jeonam.iterrows():
    sgg_nm = row['SGG_NM'].replace('전라남도 ', '')
    plt.annotate(text=sgg_nm, xy=(row.geometry.centroid.x, row.geometry.centroid.y),
                 horizontalalignment='center', fontsize=8, color='black')

ax.set_title('Regions within 20km Buffer of Non-Jeonam Hospitals')
plt.show()
```



- Through this, it was confirmed that many counties in Jeollanam-do were vulnerable to delivery with the naked eye.
- Buffer was useful in identifying the radius of service areas in vulnerable delivery areas, but this has limitations in identifying the number of women in practice and accessibility between hospitals
- To compensate for the limitations, 2SFCA tries to identify accessibility to the supply site from the perspective of the the female population of childbearing age

The 2SFCA method evaluates geographic accessibility by considering demand, supply, and mobility.

II. Analysis of Indicators for Childbirth Vulnerable Areas 2. Analysis Methods – (B) 2SFCA

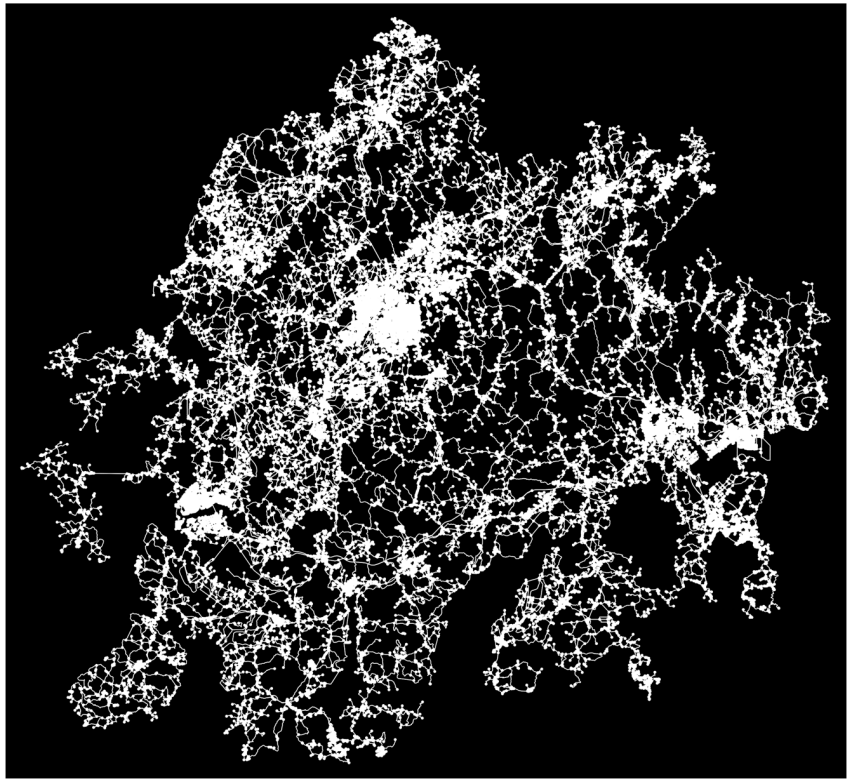


- Two Step Floating Catchment Area (2SFCA):
  A method for assessing geographical accessibility considering demand, supply, and mobility.

- Buffer Limitation Enhancement:
  Analysis conducted from the perspective of demand to assess the accessibility of supply locations.

The 2SFCA analysis for Jeollanam-do assesses accessibility within a 20 km range using district centroids and hospital locations with OSM road network data.

II. Analysis of Indicators for Childbirth Vulnerable Areas 2. Analysis Methods – (B) 2SFCA

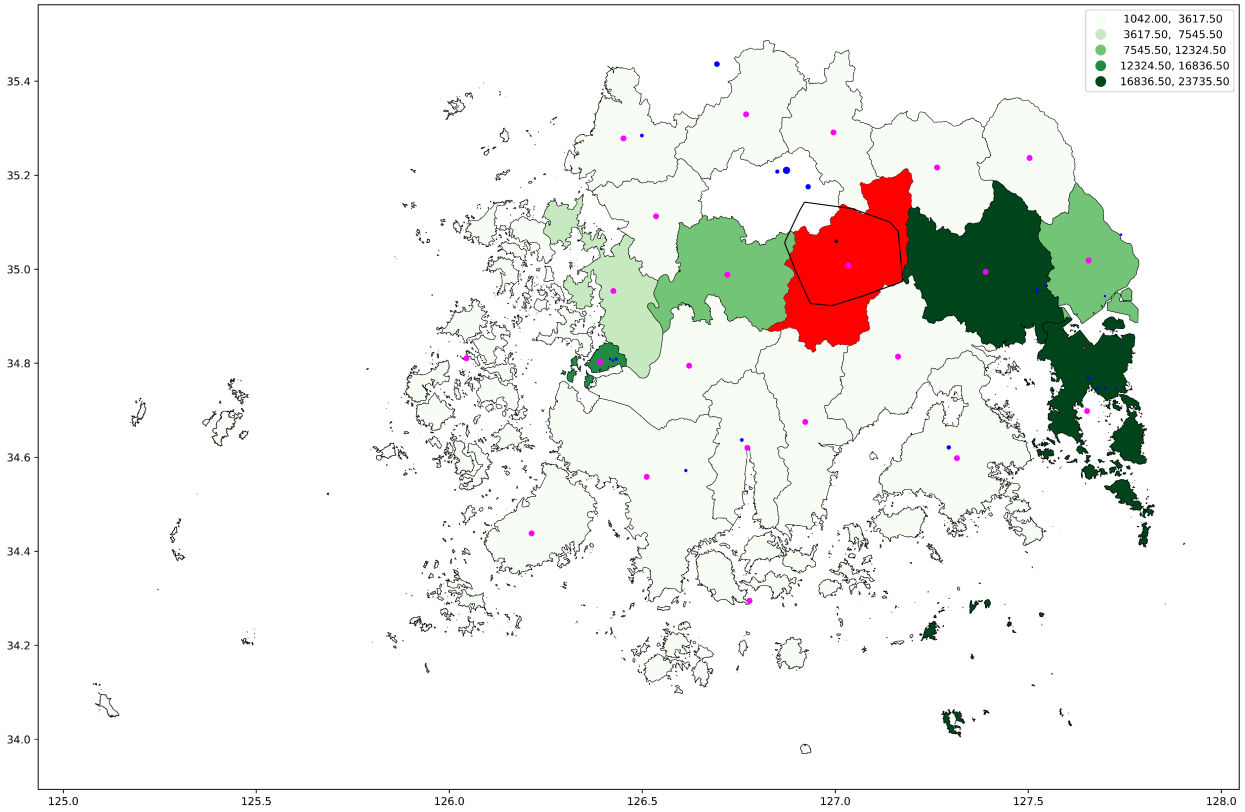


- Demand : Population of women of childbearing age (25-39 years old) in each administrative district
- Demand Points : Centroids of each administrative district in Jeollanam-do.
- Service Supply Points: Hospitals providing services in Jeollanam-do.
- Nodes · Road Network : Utilizing OSM data covering Jeollanam-do, Gwangju Si, Gochang Gun, Jeongeup Si, Sunchang Gun, Namwon Si, Hadong Gun.

Aggregate demand within a 20 km convex hull of healthcare supply points, then calculate accessibility based on reachable supply points from demand points

II. Analysis of Indicators for Childbirth Vulnerable Areas

2. Analysis Methods – (B) 2SFCA



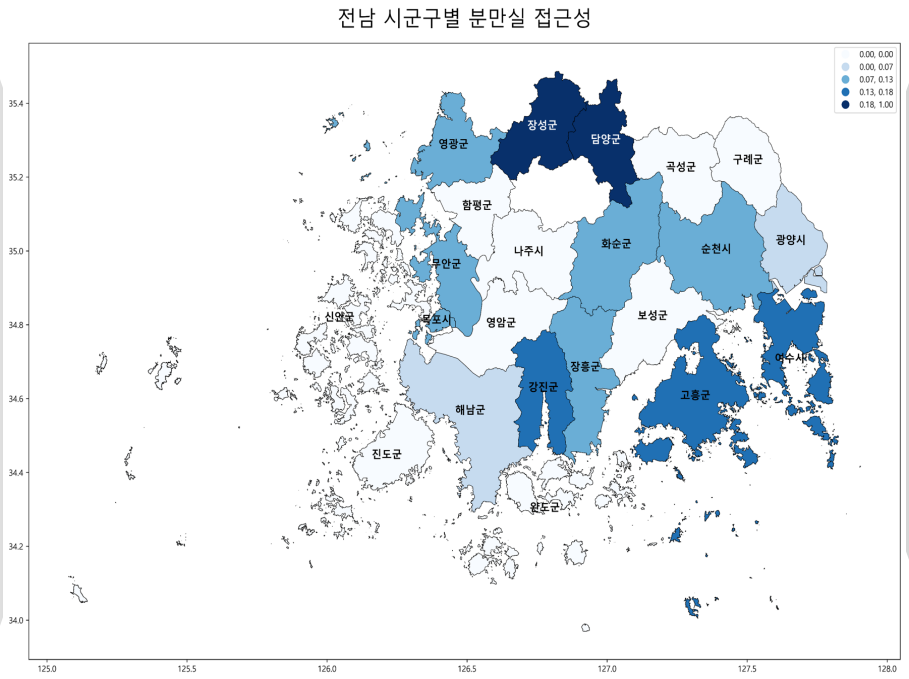
- STEP 1 : Within a 20km convex hull from delivery healthcare service supply points, aggregate potential demand from demand points included.

- STEP 2 : Considering accessible supply points from demand points, calculate accessibility.

Many districts in Jeollanam-do, including Naju and Gwangyang, have low geographical accessibility to delivery healthcare services, with scores often at 0.

II. Analysis of Indicators for Childbirth Vulnerable Areas 2. Analysis Methods – (B) 2SFCA

- Accessibility Score 0 : Naju, Yeongam, Wando, Boseong, Jindo, Sinan, Hampyeong, Gokseong, Gurye.
- Jangseong (1) and Damyang (0.966) exhibit high accessibility.
- Following them, Gangjin shows score of 0.178, indicating a significant gap between the second and third positions.



- Naku : Ranked 5th in Jeollanam-do for number of women (9944.5) Accessibility score: 0
- Gwangyang : Ranked 4th in Jeollanam-do for number of women (12324.5)
  Among areas with accessibility scores above 0, it has the lowest score (0.05).
- More than half of the administrative districts have very low geographical accessibility to delivery healthcare services.

The analysis results indicate that the vulnerable areas are Jeollanam-do at the provincial level, and Naju, Yeongam, and Gwangyang at the county level.

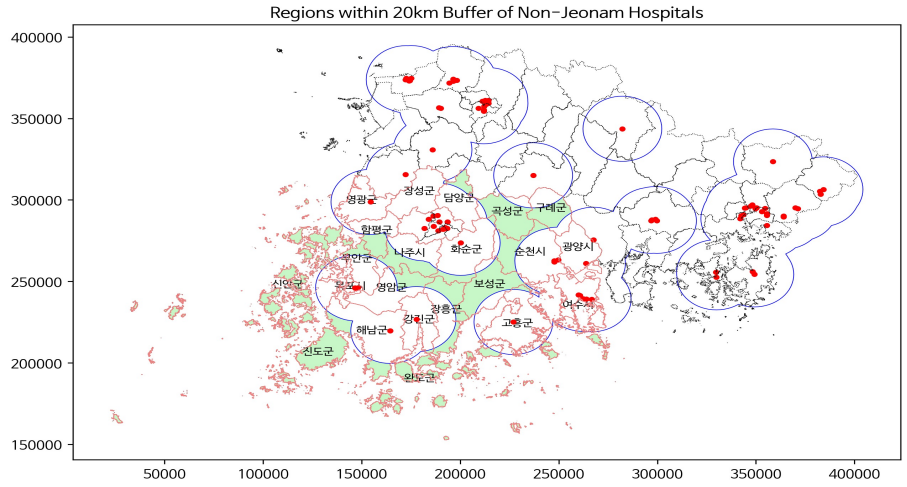
III. Conclusion 1. Status of Vulnerable Delivery Areas

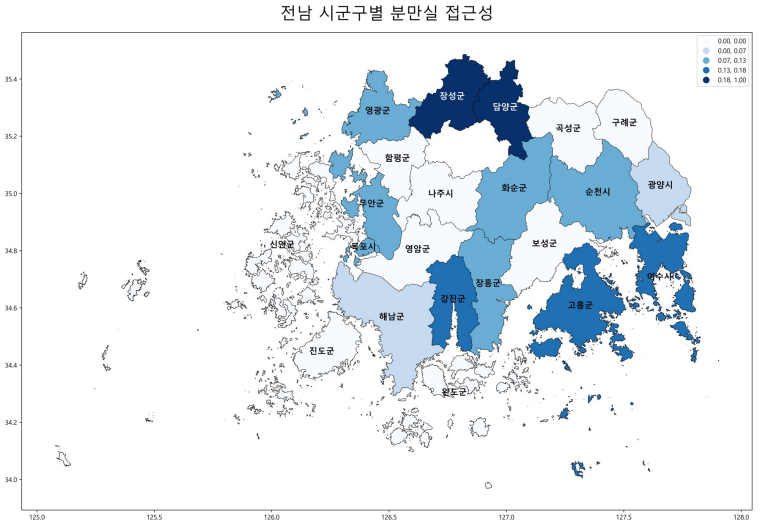
- **Naju** and **Yeongam** in Jeollanam-do have zero accessibility to delivery rooms, making them highly vulnerable despite significant populations of women of childbearing age.
- **Gwangyang** have large populations but still face delivery service shortages. Gwangyang, in particular, has over four times the women of childbearing age compared to Haenam with similar accessibility.
- Island counties **Jindo**, **Wando**, and **Sinan** face significant challenges accessing mainland delivery facilities, with Wando-gun showing high vulnerability among the zero-accessibility group.

> **“ Gwangyang are identified as vulnerable areas, differing from the Ministry of Health and Welfare's findings. ”**

Nationally-led infrastructure expansion based on accessibility and actual demand population, along with continuous monitoring, is necessary.

III. Conclusion 2. Suggestions for Improving Vulnerable Delivery Areas





- Vulnerability in delivery areas is determined by the accessibility of delivery rooms for women aged 25-39.
- To address this, delivery services need to be close to their residential centers.
- National financial support is crucial for expanding delivery infrastructure, including hospitals and clinics with obstetricians and delivery beds.
- Continuous monitoring is necessary to evaluate the impact on birth rates and to identify and adjust support for new vulnerable areas.

Thank you

김현서 | 양인성 | 이정한 | 이호준 | 장기호