GEOGRAPHICAL ACCESSIBILITY TO COMPREHENSIVE EMERGENCY OBSTETRIC AND NEWBORN CARE IN NEPAL

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Presentation Outline

- Title of the Research
- Author’s Name and Affiliation
- Background and Objective
- Methodology
- Results
- Conclusion
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- References

Trend in Maternal Mortality Ratio (MMR) in Nepal

Year	**MMR (per 100,000 live births)**
1996	539
2006	281
2011	229
2016	239
2021/23	142
(Ministry of Health and Population et al., 2023)	

Background

- Although there has been significant improvements in maternal and newborn health outcomes at the national level, there is still a lack of granular subnational evidence on progress, equity, and physical access to Comprehensive Emergency Obstetric and Newborn Care (CEmONC) services in Nepal, especially in geographically diverse and difficult-to-reach areas(Pandey et al., 2025).

- This highlights the importance of improving timely access to emergency obstetric care (CEmONC), especially in underserved areas.

Background

- Emergency obstetric and neonatal care (EmONC) services encompass essential life-saving interventions and care for women and newborns during pregnancy, childbirth, and the postpartum period during the serious problems(Tiruneh et al., 2022).

- Ensuring timely access to high-quality emergency obstetric and newborn care (EmONC) is a key strategy to reduce maternal and neonatal morbidity and mortality(Curtis et al., 2021).

Background

- GIS helps measure spatial inequities and identify underserved areas.

- Travel-time models show real access to CEmONC services which supports equitable health planning and referral systems(Ebener, et al., 2019).

Objective

General objective

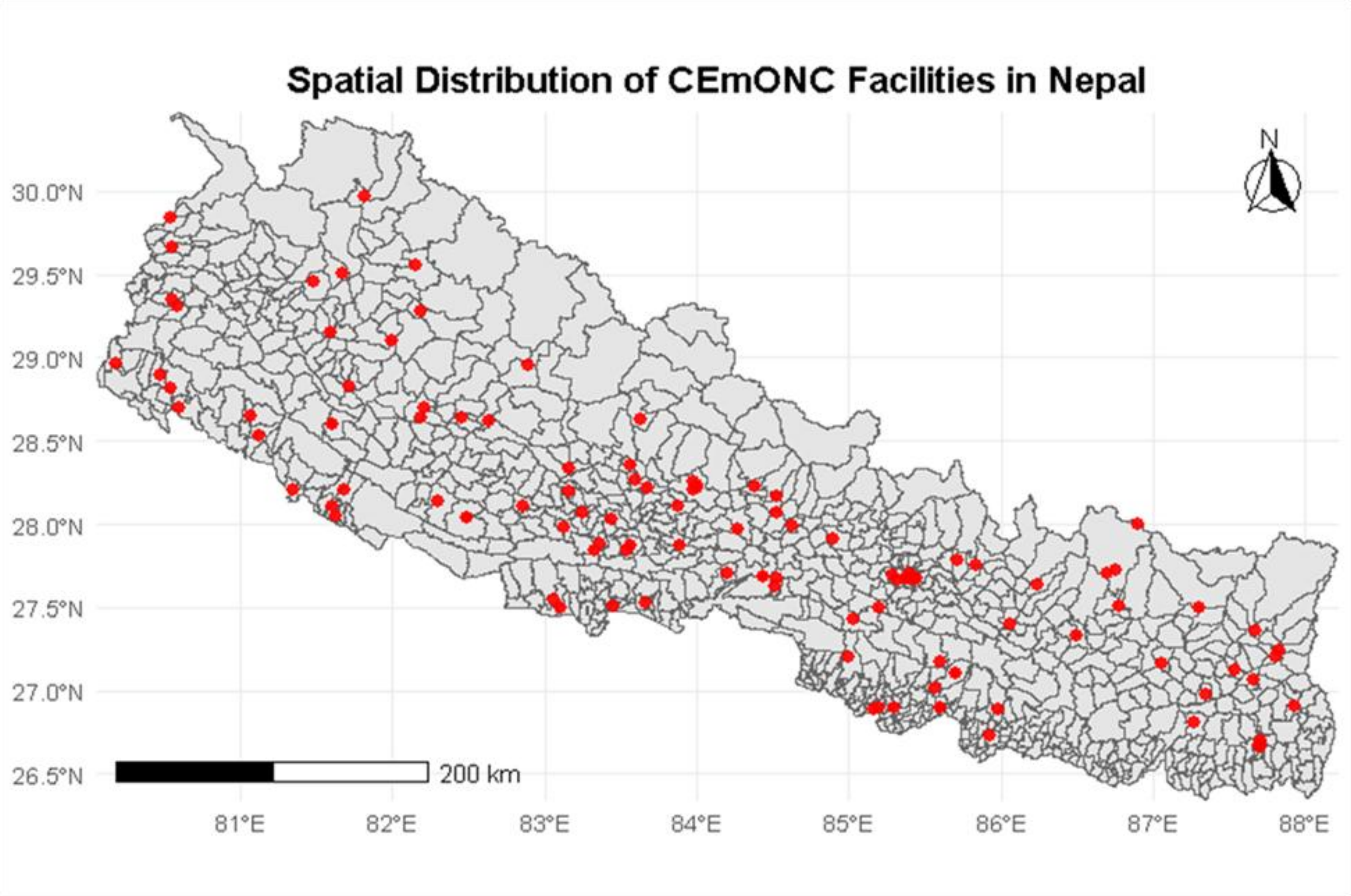
To assess the geographical accessibility to Comprehensive Emergency Obstetric and Newborn Care (CEmONC) facilities in Nepal.

Specific Objectives are:

- To map the distribution of CEmONC facilities across Nepal.
- To estimate travel time distance from each pixel to the nearest CEmONC facility.
- To estimate the population coverage under the different time threshold.

Methodology

Study Area



Spatial Distribution of CEmONC Facilities in Nepal
N
30.0°N
29.5°N
29.0°N
28.5°N
28.0°N
27.5°N
27.0°N
26.5°N
200 km
81°E
82°E
83°E
84°E
85°E
86°E
87°E
88°E

Data sources

- **CEmONC facility** locations data were collected from Public Health Update (2020) which includes hospital names and addresses.

  - Geocoded using the ‘tidygeocoder’ package in R
  - Generated geographic coordinates for spatial mapping

Population Data Source: WorldPop (2019)

- Spatial resolution: 1 km × 1 km
- Provides gridded population distribution
- Used for population-weighted travel time analysis

Data sources

Friction Surface Data

- Source: Malaria Atlas Project (2020)
- Spatial resolution: 1 km × 1 km
- Accessed using R

Key Features

- Represents travel time per unit distance.
- Incorporates: Road network, land cover, Terrain slope, Infrastructure.
- To model travel time and accessibility to health facilities which are widely used in healthcare accessibility studies.

Data sources

Administrative Boundary Data

- Source: Government of Nepal National Geoportal(National Spatial Data Center, n.d.).
- Includes national and sub-national boundaries
- Used for mapping and spatial analysis

Data Integration

Data Integration

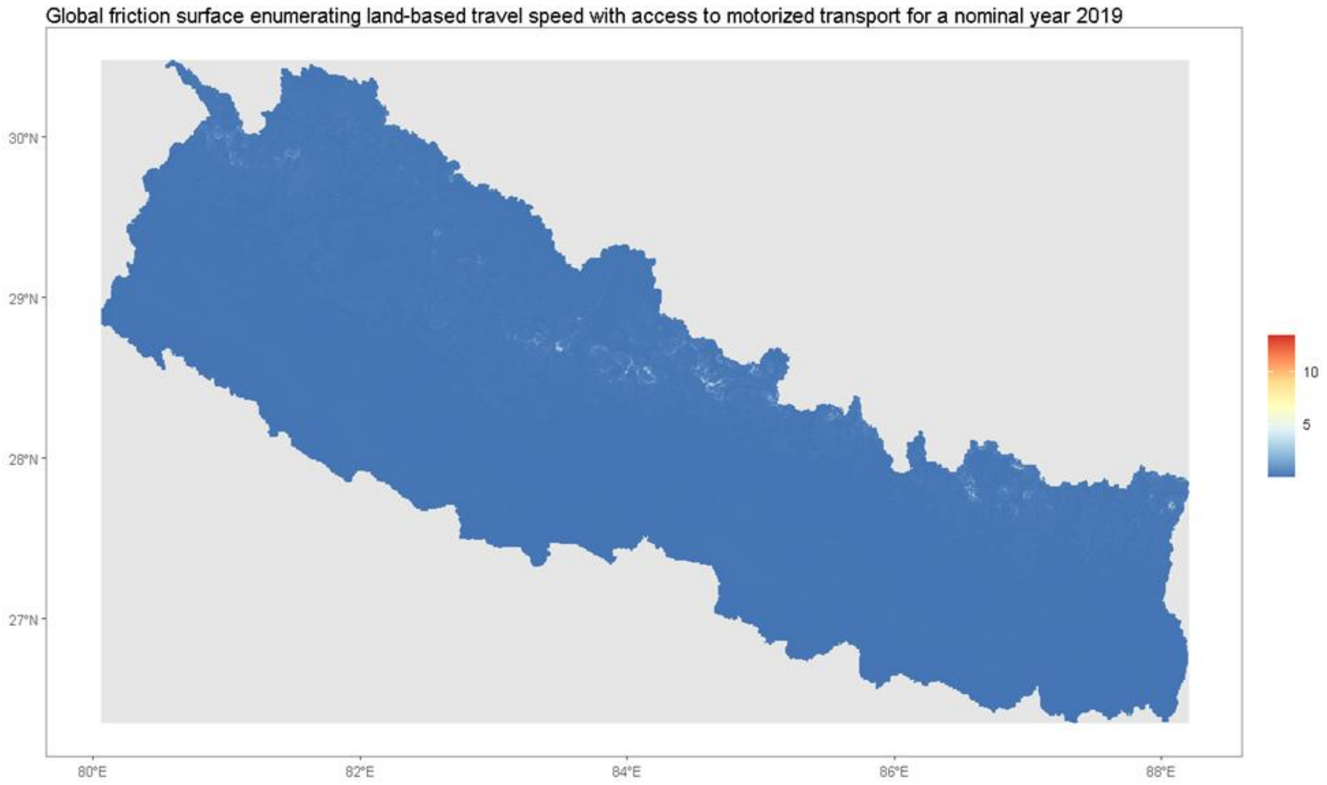
- Projection
- Resolution
- Spatial extent

Projection System

- All datasets reprojected to:
  - Universal Transverse Mercator (UTM), Zone 45

Purpose

- Ensures consistency and accuracy in spatial analysis.



Represents land-based travel speed using raster data
Low friction = faster travel; High friction = slower travel
Used to estimate travel time to CEmONC facilities and assess accessibility

Travel Time Modeling & Analysis

- Hospital locations georeferenced and overlaid on friction surface.

- Used Dijkstra’s least-cost-path algorithm to calculate minimum travel time distance using gdistance package in R.

- Continuous travel surface were categorized : 0–30 min, 30–60 min, 60–120 min, 120–240 min, >240 min.

- To quantify inequalities Lorenz Curve was used.

Analysis

- Accessibility is computed by assigning a travel-time cost to each raster cell using the friction surface, and then applying Dijkstra's least-cost-path algorithm to calculate the minimum cumulative travel time from every location (pixel) to the nearest CEmONC facility.

- The model identifies the fastest route across the landscape, producing a continuous surface where each pixel value represents the shortest travel time required to reach care.

Analysis

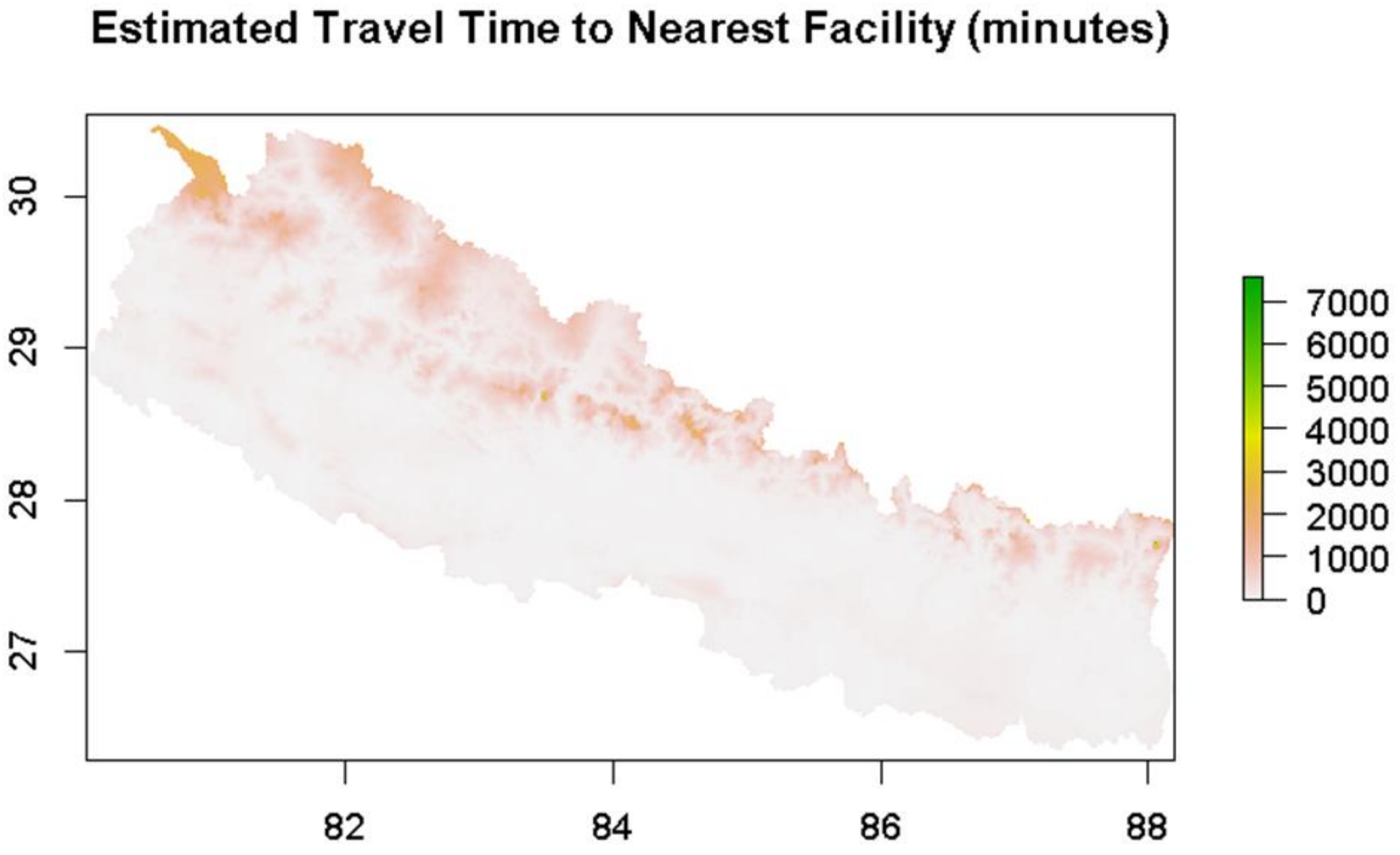
- Calculated Median Travel Time (MTT) per pixel.
- Captured spatial variation in accessibility.

Software & Tools

- R
- Packages: ‘tidygeocoder’ malariaAtlas, sf, terra, gdistance, ggplot2, tmap

Results

Travel Time to Nearest Facility Continuous surface



Travel Time to Nearest Facility

- Here,
- Light colors = shorter travel time (better access)
- Dark colors = longer travel time (poor access)

- So,
- High travel times in mountainous and remote areas

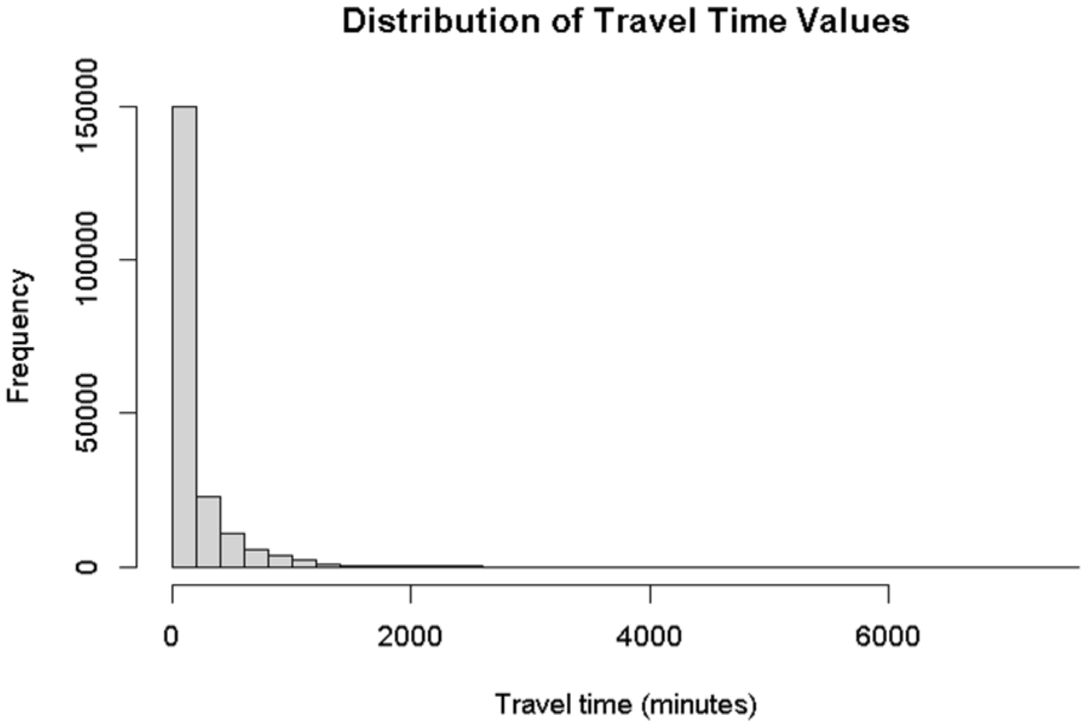
Spatial Variability in Accessibility

- Pixel-level analysis reveals substantial spatial heterogeneity in travel time across Nepal.

- Areas in Terai and urban corridors show consistently lower travel times, indicating better service reach.

- In contrast, hill and mountain regions exhibit disproportionately higher travel times, reflecting terrain and infrastructure constraints.

Distribution of Travel Time



- Travel time distribution is highly right-skewed.
- Majority of areas have low travel time (good access).
- Small proportion shows very high travel time.

So, Indicates strong inequality in accessibility.

Results

Statistic Travel Time (minutes)

- Minimum = 0.81
- 1st Quartile = 31.29
- Median = 64.74
- Mean = 181.039
- 3rd Quartile = 192.923
- Maximum = 7582.917

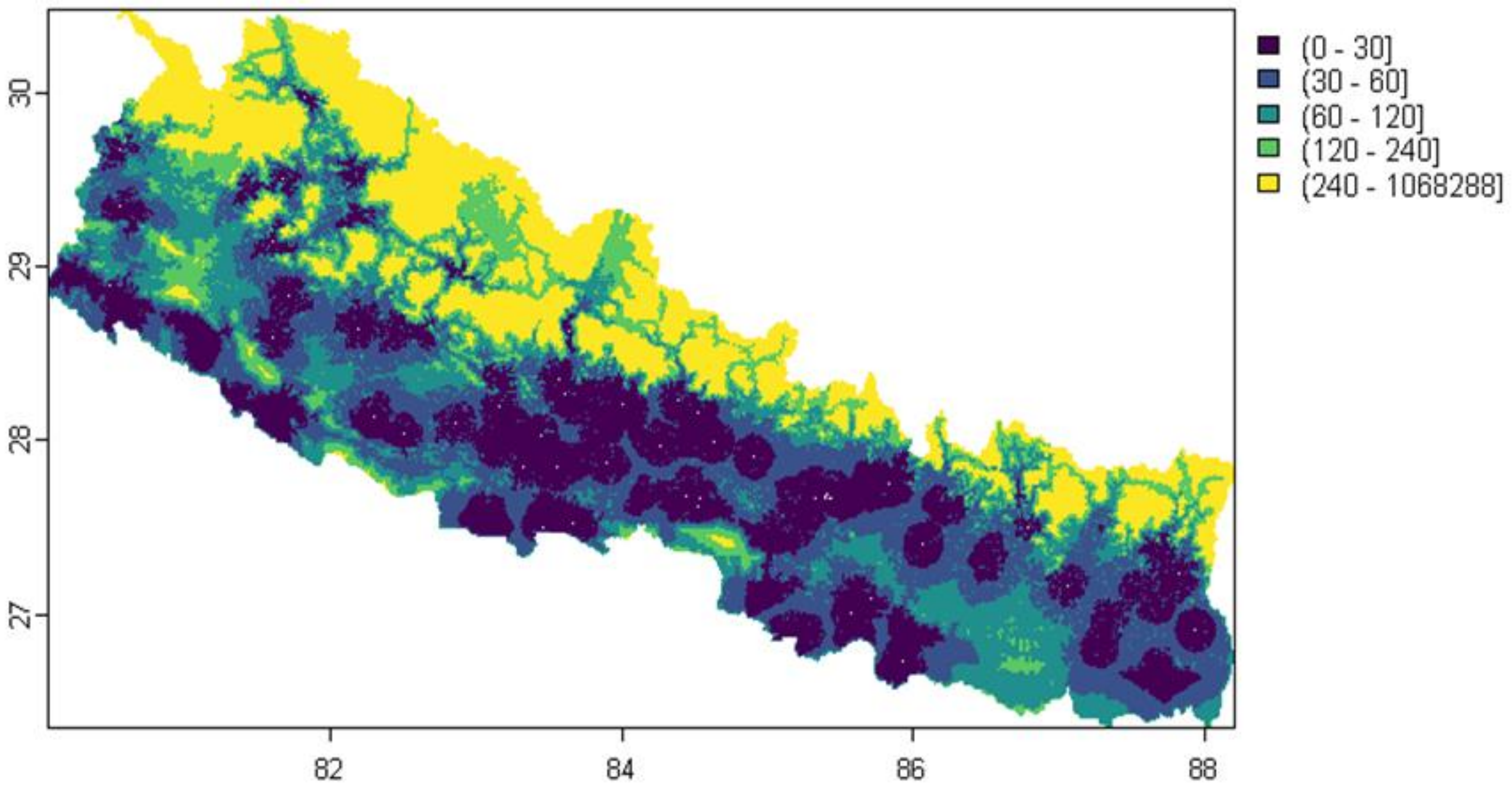
Here,

very high maximum = presence of extremely remote areas with poor access.

Results

- The interquartile range (31 to 193 minutes) indicates substantial variability in accessibility across locations.
- Median travel time (~65 minutes) suggests that at least half of the population lacks timely access to emergency obstetric care.
- The extremely high maximum value (>7500 minutes) reflects isolated and hard-to-reach populations.
- Right-skewed distribution confirms that a small proportion of areas experience disproportionately high travel burden.

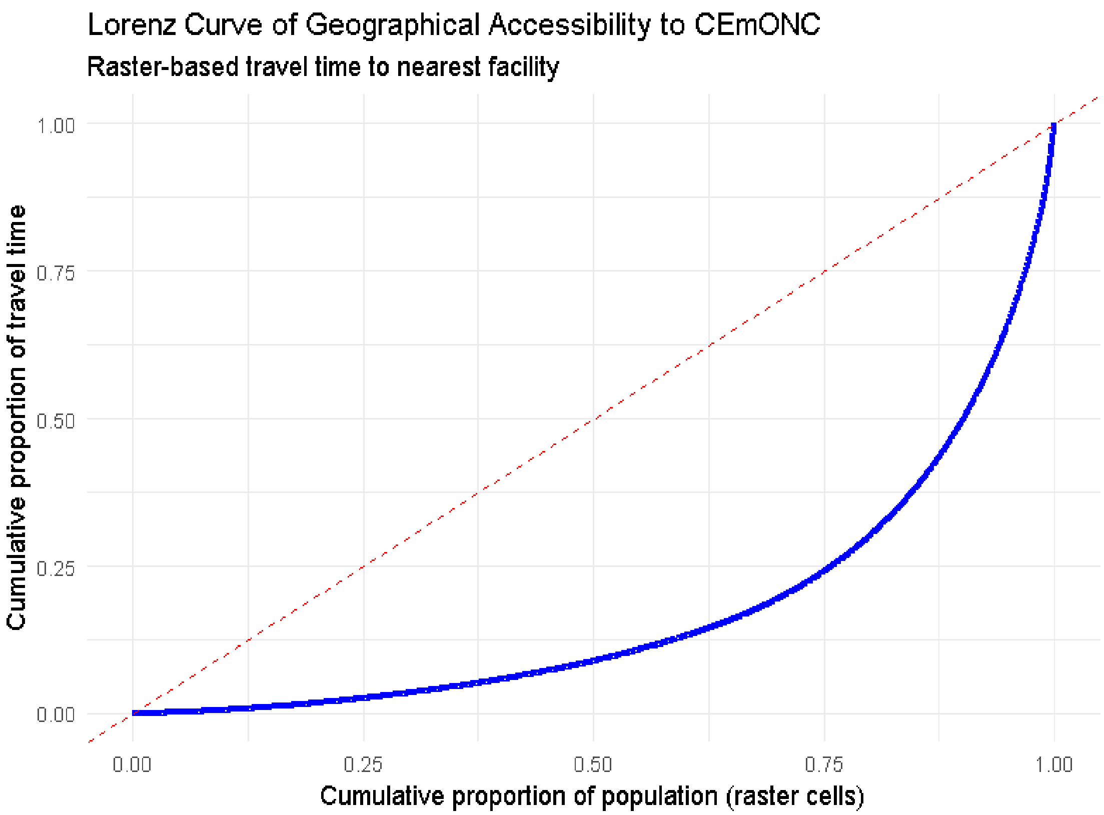
Travel time to nearest CEmONC facility modelled (in minutes)



Regional Disparities in Accessibility

- Accessibility varies significantly across ecological and administrative regions.
- Bagmati and Terai regions demonstrate relatively shorter travel times due to better infrastructure and facility concentration.
- Karnali and Sudurpashchim provinces experience prolonged travel times, often exceeding critical thresholds.
- These disparities reflect uneven distribution of health services and infrastructure gaps.

INEQUALITY IN ACCESS



Here, Lorenz curve shows high inequality in access to CEmONC facilities

- Curve lies far below the line of equality.
- Most population has short travel time.
- Small population faces very long travel time.
- .

Results

- Accessibility is not evenly distributed across space, indicating clear spatial inequity.

- This reflects a classic distance-decay effect, where utilization decreases with increasing travel time.

- Highlights the need for equity-focused health system planning.

Conclusion

- GIS-based travel time modelling effectively assessed accessibility to CEmONC services across Nepal.

- Integration of facility data, friction surface, and population data enabled evidence-based spatial analysis.

Conclusion

- Significant geographic disparities in accessibility.
- Good access (≤30 min) limited to Terai and urban/road corridors.
- Poor access (>60 min) dominates hill and mountain regions.
- Median travel time (~65 min) → many people lack timely access.
- Extremely high travel times → presence of remote and isolated areas.

Conclusion

So,

- Geographic accessibility to CEmONC remains uneven despite health progress.

- Methodology is scalable and applicable to other countries using open geospatial data.

Even though Nepal has improved outcomes, access is still unequal and that is what this study addresses.

Why Geographic Accessibility Matters

- Timely access to CEmONC is critical to:
  - Prevent maternal deaths
  - Reduce neonatal mortality
- Geographic barriers = second delay (Three Delays Model)
- Rural and mountainous populations are most affected

Acknowledgement

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About the Author

Apsara Chhetri is a Public Health graduate and a Master's student in Geo-informatics at Nepal Open University.

Her research focuses on the application of geospatial techniques to assess healthcare accessibility and spatial inequalities, particularly in Maternal and Reproductive health in Nepal.

She is interested in leveraging GIS-based evidence to inform equitable health planning and policy.

THANK YOU!